MERCURY
MerCruiser

SERVICE MANUAL

Number 25

MARINE ENGINES

GM V-6
262 CID (4.3L)

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Notice

Throughout this publication, “Dangers,” “Warnings” and “Cautions” (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “Common Sense” operation, are major accident prevention measures.

⚠ DANGER

DANGER - Immediate hazards which WILL result in severe personal injury or death.

⚠ WARNING

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠ CAUTION

Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers’ mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine, that they have been trained in the recommended servicing procedures of these products which includes the use of mechanics’ common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, during any maintenance procedure replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins for other pertinent information concerning the products described in this manual.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts, will void the warranty on those parts which are damaged as a result of the use of other than recommended replacement parts.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Sterndrives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

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Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

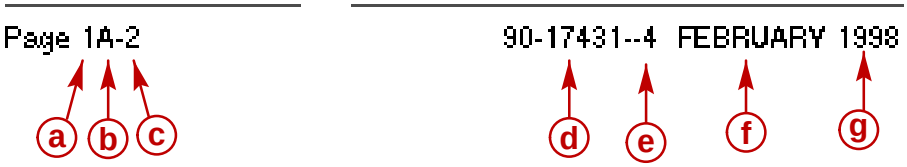
This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Sections and section parts are listed on the “Service Manual Outline” page following “V-6 Models Covered in This Manual” page.

Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



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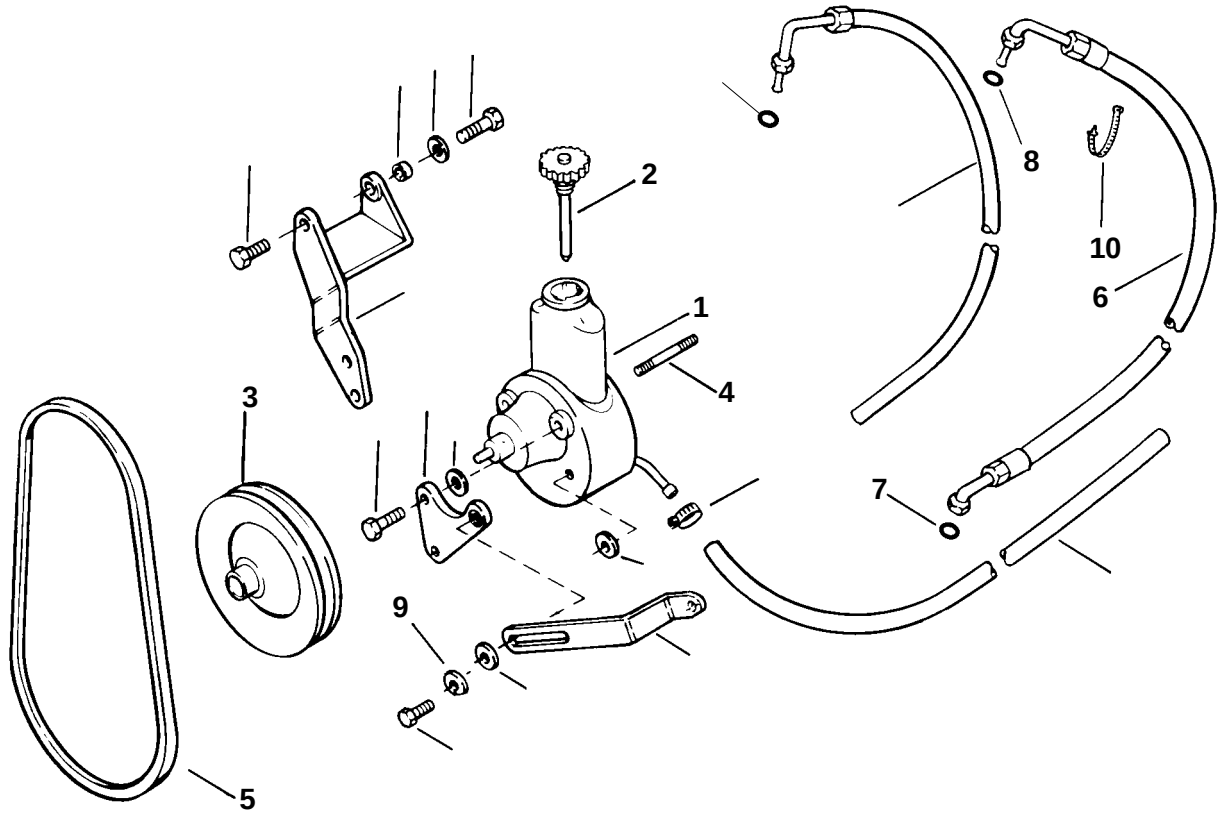
b - Section Part
c - Page Number
d - Manual Part Number
e - Revision Number
f - Month Printed
g - Year Printed

How to Read a Parts Manual

Power Steering Pump Assembly



REF. NO.	PART NO.	SYM.	QTY.	DESCRIPTION
1	90507A12		1	PUMP ASSEMBLY–Power Steering
2	36- 95805		1	CAP
3	73873A1		1	PULLEY
4	16- 41877		1	STUD
5	57- 65607T		1	V-BELT
6	32- 806684		1	HOSE–Pressure **(FITTINGS ON BOTH ENDS)**
7	25- 89879		1	O-RING
8	25- 806232		1	O-RING
9	13- 35048		1	LOCKWASHER (3/8 in.)
10	61990		1	CABLE TIE

REF. NO. : Number shown next to part on exploded view

PART NO. : Mercury Part Number for ordering. If NSS (not sold separately) sometimes GM part number will be given in description column.

QTY. : The quantity that must be ordered.

DESCRIPTION : Description of part, what parts are included with a part (all indented items come with the main item above the indented parts), serial number information, and special information.

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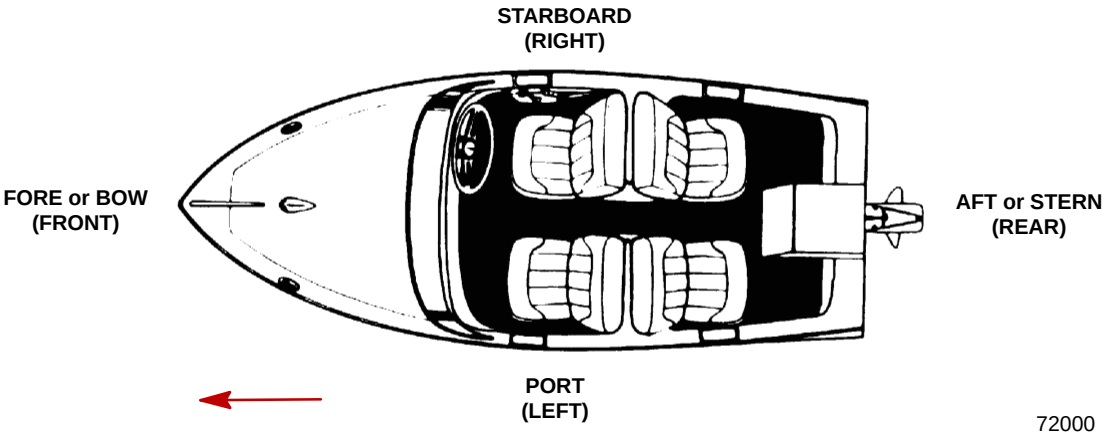
Directional References

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this manual, all directional references are given as they appear when viewing boat from stern looking toward bow.



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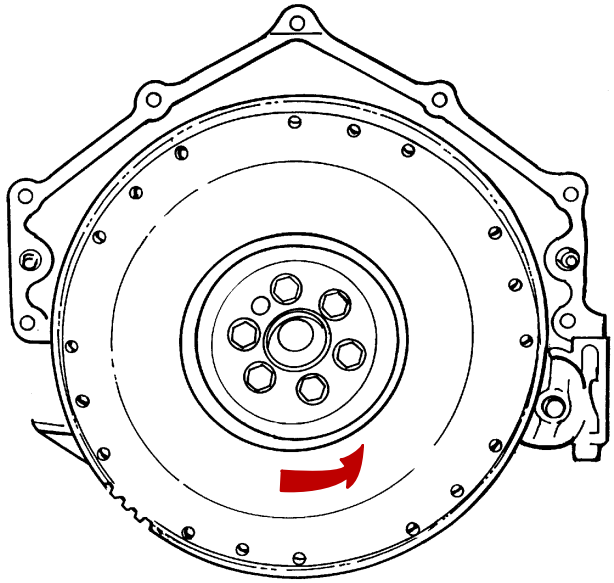
Engine Rotation

Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (toward water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



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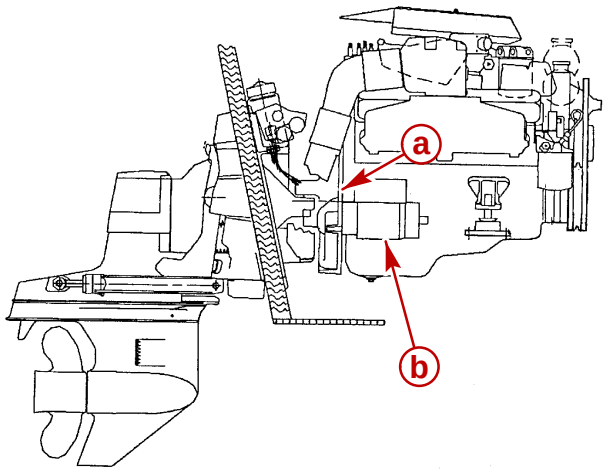
Left Hand Rotation

Engine Serial Number Location



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a - Serial Number Plate
b - Starter Motor

Propeller Information

Refer to the “Propeller” section in appropriate Mercury MerCruiser Sterndrive Service Manual, or order publication 90-8614492, “What You Should Know About Quicksilver Propellers.”

Changing diameter, pitch or coupling of a propeller will affect engine rpm and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified rpm range at wide open throttle (WOT).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at WOT and check rpm with an accurate tachometer. Engine rpm should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

If engine exceeds the specified rpm, an increase in pitch and/or diameter is required.

If engine is below rated rpm, a decrease in pitch and/or diameter is required.

Normally, a change of approximately 200 rpm will be achieved for each one inch pitch change of a propeller.

⚠ CAUTION

If a propeller is installed that does not allow engine rpm to reach the specified full-throttle rpm range, the engine will “labor” and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified rpm limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

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Water Testing New Engines

Use care during the first 20 hours of operation on new Mercury MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

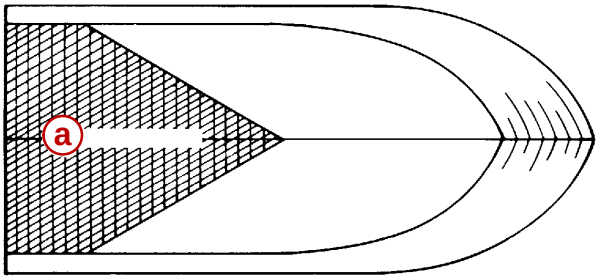
1. Start engine and run at idle rpm until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine rpm (in 200 rpm increments) until engine reaches its maximum rated rpm.

IMPORTANT: Do not run at maximum rpm for more than 2 minutes.

Boat and Engine Performance

Boat Bottom

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft (1.5 m).



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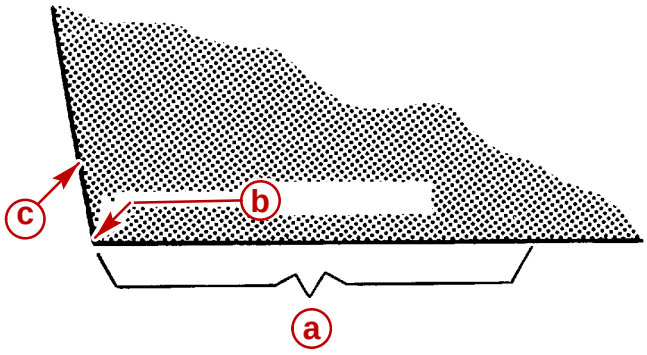
a - Critical Bottom Area

For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



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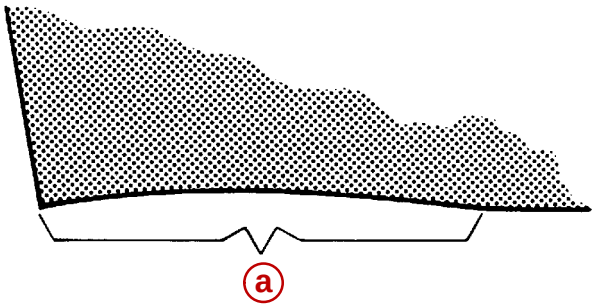
a - Bottom
b - Corner
c - Transom

The bottom is referred to as having a “hook” if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.



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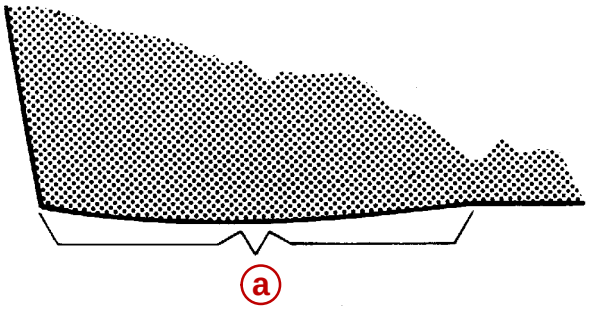
a - Hook

A “rocker” is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.



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a - Rocker

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles per hour on a fast boat.

Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occurring on the boat’s bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. Therefore, it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Antifouling paint, if required, may be applied to boat hull observing the following precautions.

IMPORTANT: DO NOT paint anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

⚠ CAUTION
Avoid corrosion damage. Do not apply antifouling paint to Mercury MerCruiser drive unit or transom assembly.

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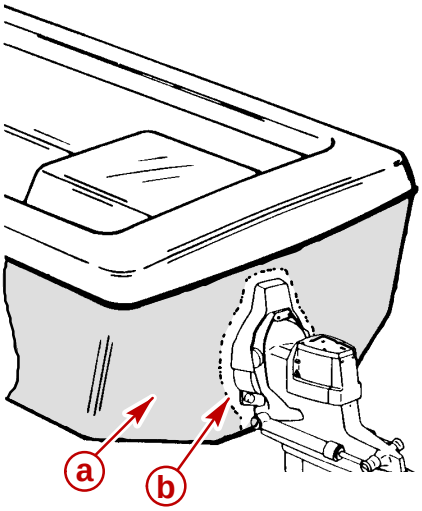
IMPORTANT: If antifouling protection is required, Tri-Butyl-Tin-Adipate (TBTA) base antifouling paints are recommended on Mercury MerCruiser boating applications. In areas where Tri-Butyl-Tin-Adipate base paints are prohibited by law, copper base paints can be used on boat hull and boat transom. Corrosion damage that results from the improper application of antifouling paint will not be covered by the limited warranty. Observe the following:

Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 1-1/2 in. (40mm) UNPAINTED area on transom of the boat around these items.



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a - Anti-Fouling Paint
b - Minimum 1-1/2 in. (40 mm) UNPAINTED Area

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight - cargo and passengers - should be as far aft as possible to allow the bow to come up to a more efficient angle (3 to 5 degrees). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his/her needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

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Water in Boat

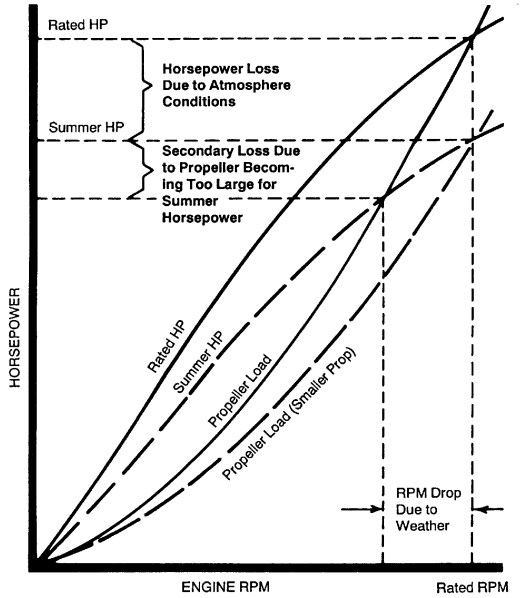
When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly apparent when an engine is propped out on a cool dry day in spring and later, on a hot, humid day in August, does not have the same performance. See chart below.

Although some performance can be regained by dropping to a lower pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated rpm under a specific combination of weather conditions.



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IMPORTANT INFORMATION

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1 B

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Tools

Description	Part Number
Timing Light	91-99379
Quicksilver Scan Tool	91-823686A2

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite Pipe Sealant With Teflon	Obtain Locally
Quicksilver U-Joint and Gimbal Bearing Grease	92-828052A2

Maintenance Schedules

Maintenance Intervals

Maintenance intervals and the tasks to be performed, as shown in this current schedule, or as found in a previously printed schedules, are generally based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, Mercury MerCruiser has adjusted some maintenance intervals and corresponding tasks to be performed. In some cases, this may allow for more individual tasks to be performed in a single visit to the serving dealer, rather than multiple visits. Therefore, it is very important that the boat owner and servicing dealer discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, environment, and maintenance requirements.

⚠ CAUTION

Always disconnect battery cables from battery BEFORE working around electrical systems components to prevent injury to yourself and damage to electrical system should a wire be accidentally shorted.

Gas Sterndrive

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	●★			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		●★		
Check drive unit oil level, trim pump oil level and power steering pump fluid level.			●★	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			●★	
Inspect drive unit anodes and replace if 50 percent eroded.			●★	
Inspect fuel pump sight tube and have pump replaced if fuel is present.			●★	
Check battery connections and fluid level.				●★
Lubricate propeller shaft and the retorque nut (if operating in only freshwater, this maintenance may be extended to every four months).				●★
Operating in Saltwater Only: treat engine surface with corrosion guard.				●★
Clean air filter every 50 hours of operation.				●★

* Only perform maintenance which applies to your particular power package

● Standard Models

★ Horizon Models

Index

Gas Sterndrive(Continued)

Scheduled Maintenance *

	Annually	Every 100 hours or Annually	Every 200 hours or 3 years	Every 300 hours or 3 years	Every 2 years	Every 5 years
Touch-up paint power package and spray with corrosion guard.	●★					
Change crankcase oil and filter.		●★				
Change drive unit oil and retorque connection of gimbal ring to steering shaft.		●★				
Replace fuel filter(s).		●★				
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		●★				
Inspect U-joints, splines and bellows. Check clamps. Check engine alignment. Lubricate U-joints splines.		●	★			
Lubricate gimbal bearing and engine coupler.		●8	★			
Check continuity circuit for loose or damaged connections. Test MerCathode® unit output on Bravo Models.		●	★			
Retorque engine mounts.		●		★		
Check spark plugs, wires, distributor cap and ignition timing. Check and adjust idle speed.		●		★		
Clean flame arrestor and crankcase ventilation hoses. Replace PCV valve.		●		★		
Check electrical system for loose, damaged or corroded fasteners.		●		★		
Inspect condition and tension of belts.		●		★		
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.		●		★		
Disassemble and inspect seawater pump and replace worn components.		●		★		
Clean seawater section of closed cooling system. Clean, inspect and test pressure cap.		●		★		
Replace coolant.					♠	●★

* Only perform maintenance which applies to your particular power package

● Standard Models

★ Horizon Models

◆ Whichever Occurs First

♠ Interval will be reduced if not using extended life coolant.

8 Lubricate engine coupler every 50 hours if operated at idle for prolonged periods of time.

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Engine and Tune-Up Specifications

MCM (Sterndrive)

Model	MCM 4.3L ALPHA / BRAVO	MCM 4.3LH ALPHA / BRAVO	MCM 4.3L EFI ALPHA / BRAVO
Propshaft Horsepower (SAV1 Rating)	190	205 (190)[2]	210[1] (188)2
Propshaft Kilowatts (SAV1 Rating)	142	153 (142)[2]	157[1] (146)[2]
Number of Cylinders	V-6		
Displacement	262 cid (4.3 l)		
Bore / Stroke - in. (mm)	4.0 x 3.48 (101.6 x 88.4)		
Compression Ratio	9.4:1		9.4:1
Compression Pressure	Minimum 100 psi (690 kPa)[7]		
Idle rpm In Neutral[3]	650 rpm[5]		600 rpm[5]
Maximum rpm (at WOT)[3]	4400-4800 rpm		
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)		
Minimum Oil Pressure (at Idle)	Minimum 4 psi (28 kPa)		
Fuel Pressure (1800 rpm)	3-7 psi (21-48 kPa)		30 psi (kPa)
Electrical System	12 V Negative (–) Ground		
Alternator Rating	55 or 65 amp [8]		
Minimum Battery Requirements	375 cca / 475 mca / 90 Ah		
Firing Order	1-6-5-4-3-2		
Spark Plug Type	AC - MR43LTS Champion - RS12YC NGK - BPR6EFS		
Spark Plug Gap	.045 in. (1.1 mm)		
Timing (at idle rpm)[4]	10° BTDC		8° BTDC
Preliminary Idle Mixture	1 1/4 Turns		DNA
Thermostat	160° F (71° C)		

[1] Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Power Rated in Accordance with SAV1 rating procedures. This rating procedure is used to certify that the engine complies with "Stage 1" Bodensee and Swiss Regulations. Horsepower differences shown result from differences in test rpm, allowable test tolerances, and/or installation of special kit components.

[3] Measured using an accurate service tachometer with engine at normal operating temperature.

[4] Timing must be set using a special procedure as outlined in the appropriate section of this manual. Timing cannot be properly set using the conventional method.

[5] A special procedure must be followed to adjust idle rpm. Consult your Authorized Mercury MerCruiser Dealer before attempting this procedure.

[6] Idle speed on EFI models is not adjustable.

[7] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

[8] Serial Number Break for 65 Amp alternator: OL619083 and above.

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Fluid Capacities

NOTICE
Unit Of Measurement: U.S. Quarts (Liters)
All capacities are approximate fluid measures.

Sterndrive Engines

Model	All Models
Crankcase Oil (With Filter) [1]	4-1/2 (4.3)
Seawater Cooling System [2]	15 (14.1)
Closed Cooling System	20 (19)

[1] Always use dipstick to determine exact quantity of oil or fluid required.

[2] Seawater Cooling System capacity information is for winterization use only.

Sterndrives

NOTICE
Unit Of Measurement: U.S. Fluid Ounces (Milliliters)
All capacities are approximate fluid measures.

Model	ALPHA ONE
Drive Unit Oil Capacity (With Gear Lube Monitor)	64 (1892)

Model	BRAVO ONE	BRAVO TWO	BRAVO THREE
Drive Unit Oil Capacity (With Gear Lube Monitor)	88 (2603)	104 (3076)	96 (2839)

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20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 rpm for extended periods of time for first 10 hours. Shift into gear as soon as possible after starting and advance throttle above 1500 rpm **if conditions permit safe operation.**
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during first 10 hours. During next 10 hours, occasional operation at full throttle is permissible (5 minutes at a time maximum).
- Avoid full throttle acceleration from IDLE speed.
- Do not operate at full throttle until engine reaches normal operating temperature.

After Break-in Period

To help extend the life of your Mercury MerCruiser power package, the following recommendations should be considered:

- Use a propeller that allows the engine to operate at or near the top of the maximum rpm range (refer to “Specifications” section) when at full throttle with a normal boat load.
- Operation at 3/4 throttle setting or lower is recommended. Refrain from prolonged operation at maximum (full throttle) rpm.

End of First Season Checkup

At the end of the first season of operation, an Authorized Mercury MerCruiser Dealer should be contacted to discuss and/or perform various scheduled maintenance items. If you are in an area where the product is operated continuously (year-round operation), you should contact your dealer at the end of the first 100 hours of operation, or once yearly, whichever occurs first.

CA261

Specifications

Fuel Recommendations

IMPORTANT: Use of improper gasoline can damage your engine seriously. Engine damage resulting from use of improper gasoline is considered misuse of engine, and damage caused thereby will not be covered under the limited warranty.

FUEL RATINGS

Mercury MerCruiser engines will operate satisfactorily when using a major brand of unleaded gasoline as follows:

USA and Canada - having a posted pump Octane Rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable. DO NOT use leaded gasoline.

Outside USA and Canada - having a posted pump Octane Rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

CA291

USING REFORMULATED (OXYGENATED) GASOLINES (USA ONLY)

This type of gasoline is required in certain areas of the USA. The two types of “oxygenates” used in these fuels are Alcohol (Ethanol) or Ether (MTBE or ETBE). If Ethanol is the “oxygenate” that is used in the gasoline in your area, refer to “Gasolines Containing Alcohol.”

These “Reformulated Gasolines” are acceptable for use in your Mercury MerCruiser engine.

VAPOR LOCKING

Fuels containing alcohol and winter grade fuels will aggravate vapor lock problems. A vapor lock condition can be identified by the following problems:

- Engine starts and, upon advancing throttle, shuts off and will not restart.
- If engine does restart, it shuts off when advancing throttle.
- Engine is difficult to restart after operating the boat and then leaving the engine off for 1 to 3 hours.

Other factors may combine to increase vapor locking. These factors include but are not limited to:

- air temperature
- fuel tank location
- fuel supply system
- engine coolant temperature
- temperature and vacuum of fuel to engine
- engine compartment air temperature and ventilation

Other conditions should be ruled out before treating the problem as vapor locking.

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GASOLINES CONTAINING ALCOHOL

If the gasoline in your area contains either “methanol” (methyl alcohol) or “ethanol” (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with “methanol.” Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat’s fuel system will withstand. Contact your boat manufacturer for specific recommendations on the boats fuel system components (fuel tanks, fuel lines and fittings). Be aware that gasolines containing alcohol may cause increased:

- Corrosion of metal parts.
- Deterioration of rubber or plastic parts.
- Fuel permeation through rubber fuel lines.
- Starting and operating difficulties.

⚠ WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic metal or fiberglass, fuel lines, fittings, fuel filters and carburetors/fuel injection components should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a Mercury MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Test For Alcohol Content In Gasoline

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

PROCEDURE

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes**. If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid or automatic transmission Fluid (ATF) Dexron III.

Coolant for Closed Cooling System

⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of closed cooling system be filled with Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with purified water. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

If any non-compatible coolant is added to this coolant, coolant must be changed every 2 years or 400 hours, whichever occurs first. All coolants other than Extended Life 5/100 Ethylene Glycol Antifreeze/Coolant must be changed every 2 years or 400 hours, whichever occurs first.

Mercury MerCruiser V-8 engines can use any type of permanent antifreeze or any brand antifreeze solution that meets GM specification 1825M.

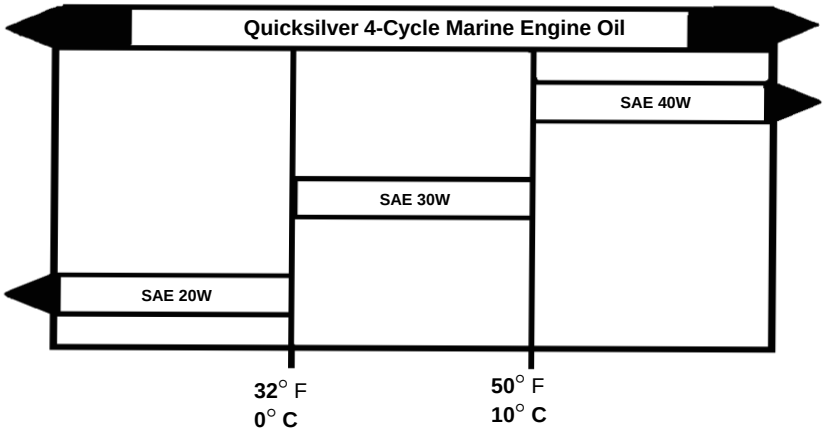
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle 25W-40 Marine Engine Oil. This oil is a special blend of 25-weight and 40-weight oils for marine engines. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SH,CF/CF-2, may be used.

In those areas where Quicksilver 4-Cycle 25W-40 Marine Engine Oil or a recommended straight weight oil are not available, a multiviscosity 20W-40 (SH, CF/CF-2) or, as a second but less preferable choice, 20W-50, with API service ratings of SH, CF/CF-2 may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than Quicksilver 25W-40 or a good quality 20W-40 or 20W-50), synthetic oils, low quality oils or oils that contain solid additives are specifically not recommended.

The chart below is a guide to crankcase oil selection. The oil filter should always be changed with oil.



Overfilled Crankcase Oil

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm “clatter” on Mercury MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to “bleed down.” This, in turn, results in rocker arm “clatter” and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a “false reading,” make sure the following steps are done before checking the oil level.

- Boat “at rest” in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting “at rest” in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

Checking Engine Oil Level / Filling

IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick.
4. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.
5. Remove dipstick and note the oil level.
6. Oil level must be between the FULL or OP RANGE and ADD marks.
7. If oil level is below ADD mark, proceed to Steps 8. and 9.
8. Remove oil filler cap from valve rocker arm cover.
9. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

Changing Oil and Filter

1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

IMPORTANT: If engine is factory equipped with Quick Drain Oil Hose, pull tether through bilge drain before removing drain plug from oil drain hose.

NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil and install. Tighten filter securely (following filter manufacturer's instructions). Do not overtighten.
7. Fill crankcase with oil. See "Specifications" for type of oil and quantity.
8. Check dipstick to ensure oil level is up to, but not over, FULL or OP RANGE mark on dipstick.
9. Start engine and check for leaks.

Changing Water Separating Fuel Filter

⚠ WARNING

Be careful when changing water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Be sure ignition key is OFF. Do not smoke or allow spark or open flame in area when changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

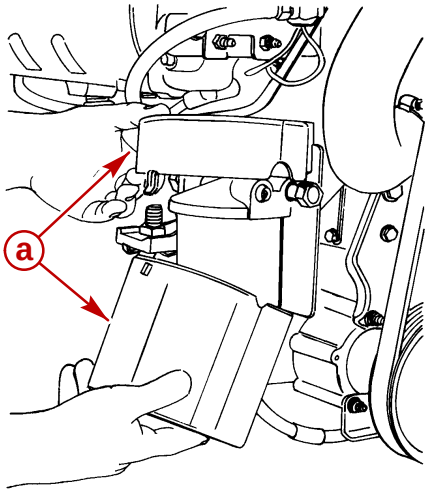
⚠ CAUTION

The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

The installation of additional filters may cause:

- Fuel Vapor Locking
- Difficult Warm-Starting
- Piston Detonation Due to Lean Fuel Mixture
- Poor Driveability

1. Unsnap latch and slide top and bottom cover pieces, if equipped, from around the water separating fuel filter and bracket.

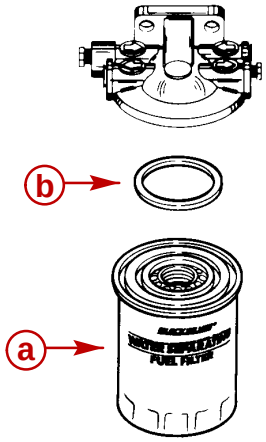


75034

a - Fuel Filter Cover

NOTE: *Top and bottom cover pieces are formed with a groove on each side that slides around the brackets outer edges.*

2. Remove water separating fuel filter and sealing ring from mounting bracket and discard.



70573

a - Fuel Filter
b - Sealing Ring

3. Coat sealing ring on new filter with motor oil.
4. Thread filter onto bracket and tighten securely by hand. Do not use a filter wrench.
5. Start and run engine.
6. Check filter connection for gasoline leaks. If leaks exist, recheck filter installation.
7. Install cover pieces around fuel filter. Be certain top part of cover latches to lower part.

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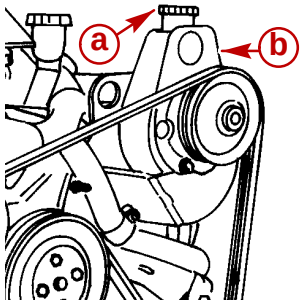
Power Steering System

Checking Fluid Level

ENGINE WARM

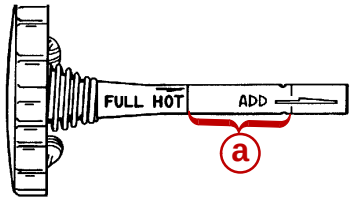
1. Stop engine. Position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.



74908

a - Fill Cap / Dipstick
b - Power Steering Pump

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



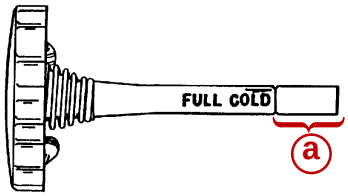
72518

a - Proper Fluid Level with Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF) Dexron III through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Engine Cold

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



72519

a - Proper Fluid Level with Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic Dexron III transmission fluid (ATF), through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.

If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

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Filling and Bleeding

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause power steering system to become spongy, which may result in poor boat control.

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump.
3. Add Quicksilver Power Trim and Steering Fluid or Dexron III automatic transmission fluid (ATF), as required, to bring level up to FULL COLD mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or Dexron III automatic transmission fluid (ATF), in power steering system.

4. Turn steering wheel back and forth to end of travel in each direction several times.
5. Recheck fluid level and add fluid, if necessary.
6. Install vented fill cap. Tighten securely.

⚠ CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.

7. Start engine and run at fast idle (1000-1500 rpm) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
8. Position drive unit so that it is straight back and stop engine.
9. Remove fill cap from pump.
10. Allow any foam in pump reservoir to disperse.
11. Check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL**.**
12. Reinstall fill cap. Tighten securely.

IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

13. If fluid is still foamy (in Step 5.), repeat Steps 7. through 12. until fluid does not foam and level remains constant.

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Closed Cooling System

Checking Coolant Level

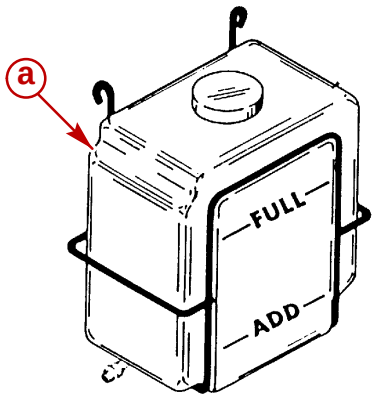
⚠ CAUTION

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Coolant level in heat exchanger should be full (to bottom of filler neck).

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts on filler neck.

2. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature.



72520

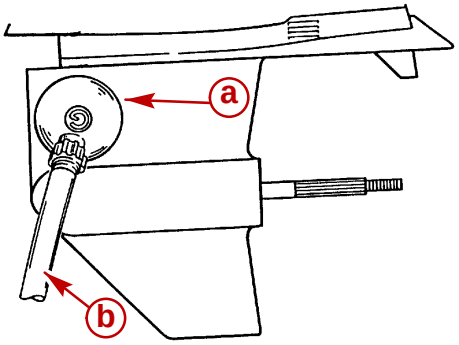
a - Coolant Recovery Reservoir

Flushing System

If engine is operated in salty, polluted or mineral-laden water, flush seawater cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush the seawater cooling system prior to storage.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

1. Install flushing attachment and water hose over the water pickup holes in gear housing.



72693

a - Flushing Attachment
b - Hose

⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

2. Open water tap enough to cool the engine, about ½ of its maximum capacity. Adjust as required so that the engine does not overheat.
3. With drive in neutral gear, start engine and advance the throttle until the engine reaches 1300 rpm.

IMPORTANT: DO NOT run the engine at idle rpm. Watch engine temperature gauge on dash. Do not run the engine above 1500 rpm or engine overheating may occur.

4. Run engine for 10 minutes or until the discharge water is clear.
5. Slowly return the throttle to the idle position and turn engine off.

IMPORTANT: DO NOT rapidly advance or return throttle as this can cause water ingestion.

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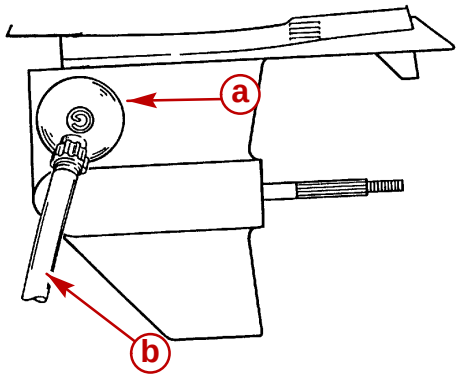
BOAT IN WATER

1. Raise drive unit to full UP / OUT position.
2. Install flushing attachment over water pickup holes in gear housing as shown.
3. Attach a water hose between the flushing attachment and a water tap.



72693

a - Flushing Attachment
b - Hose

4. Lower drive unit to full DOWN / IN position.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

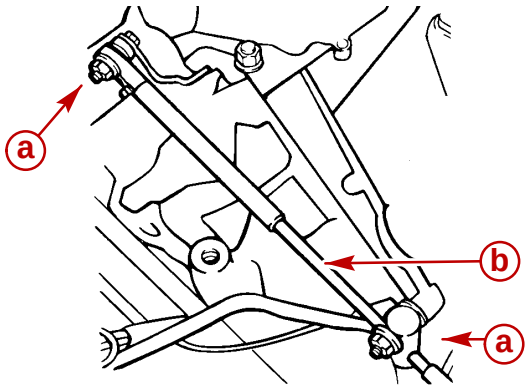
Watch temperature gauge on dash to ensure that engine does not overheat.

5. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
6. Place remote control in neutral, idle speed position, and start engine.
7. Operate engine at idle speed in neutral for 10 minutes, then stop engine.
8. Shut off water tap.
9. Raise drive unit to full UP / OUT position.
10. Remove water hose and flushing attachment.

Lubrication

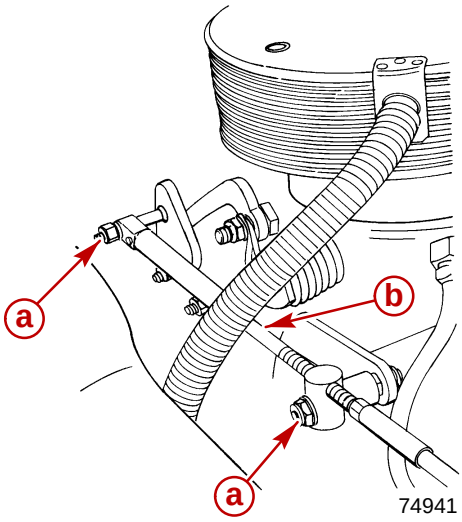
Throttle Cable

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.



71359

2 Barrel Carbureted Models



74941

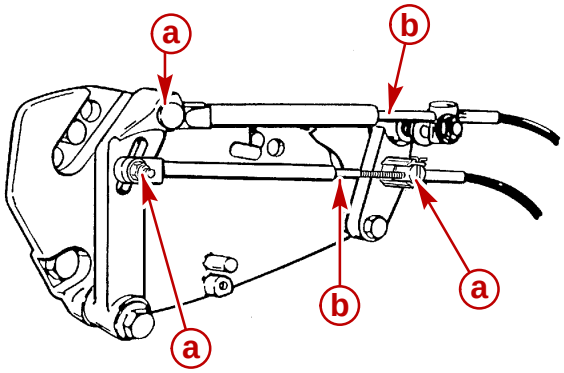
EFI Models

a - Pivot Points
b - Guide Contact Surface

Shift Cable

MCM (STERNDRIVE) MODELS

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.



72016

Typical Shift Cable

a - Pivot Points
b - Guide Contact Surface

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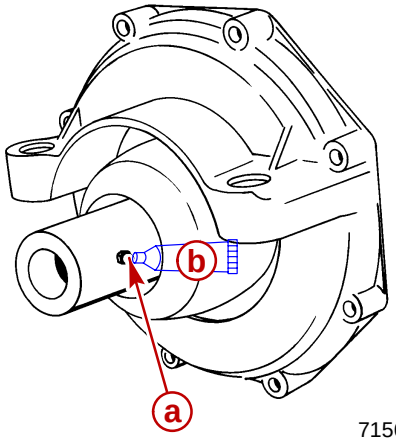
Engine Coupler / U-Joint Shaft Splines

NOTE: *Engine coupler and shaft splines are greased with Quicksilver Engine Coupler Spline Grease, 92-816391A4; universal joints are greased with Quicksilver 2-4-C Marine Lubricant.*

NOTE: *Refer to Mercury MerCruiser Sterndrive Service Manual for sterndrive unit removal and installation, if necessary.*

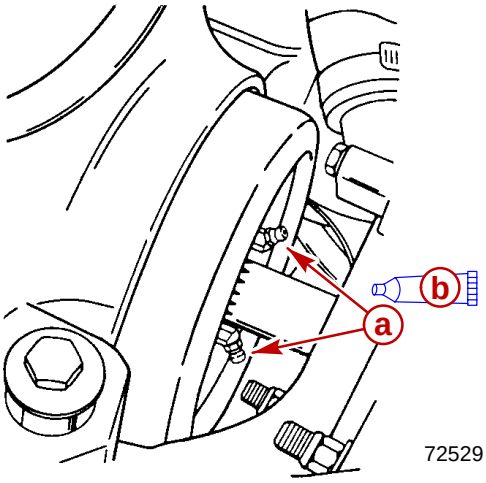
IMPORTANT: Sterndrive Unit does not have to be removed to grease coupler.

1. Lubricate engine coupler splines through grease fitting on coupler by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun.



71569

Typical Alpha Drive Coupler

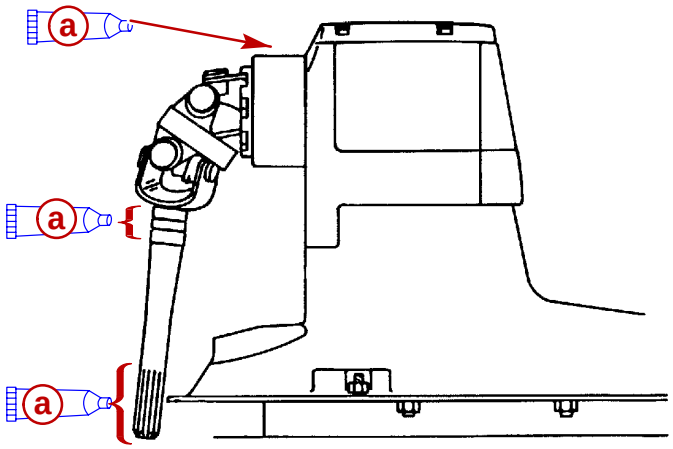


72529

Typical Bravo Drive Coupler

IMPORTANT: Later Bravo Models may be equipped with a coupler that is similar to the Alpha Coupler.

a - Grease Fitting
b - Quicksilver Engine Coupler Spline Grease



72531

Typical Bravo Drive

a - Quicksilver Engine Coupler Spline Grease

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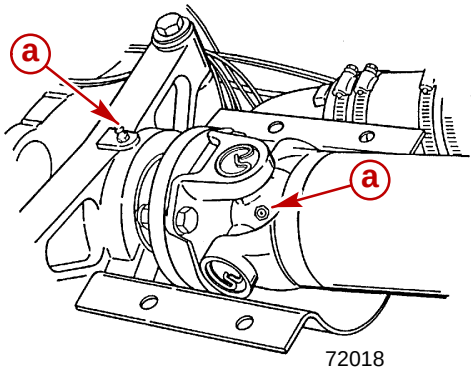
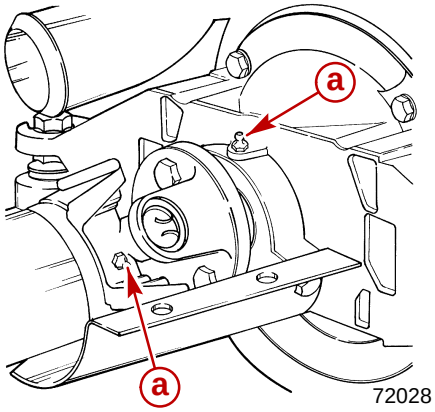
Sterndrive Drive Shaft Extension Models





Transom End **Engine End**

a - Grease Fitting

Cleaning Flame Arrestor

⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor and crankcase ventilation hoses. Be sure that ignition is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hoses.

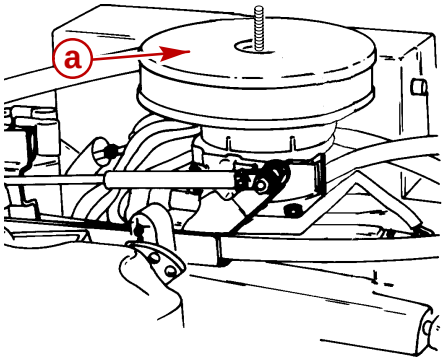
⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. NEVER use gasoline as a cleaning solvent.

Index

Top Mounted Flame Arrestor

1. Remove flame arrestor cover.
2. Remove crankcase ventilation hose from fitting on side of flame arrestor housing.
3. Remove flame arrestor.



76501

a - Flame Arrestor

4. Clean flame arrestor in solvent. Blow dry with compressed air.
5. Clean crankcase ventilation hose in solvent. Blow dry with compressed air.
6. Inspect crankcase ventilation hose for cracks or deterioration and replace if necessary.
7. Reinstall flame arrestor and crankcase ventilation hose.
8. Reinstall flame arrestor cover.

Serpentine Drive Belt

Component Location

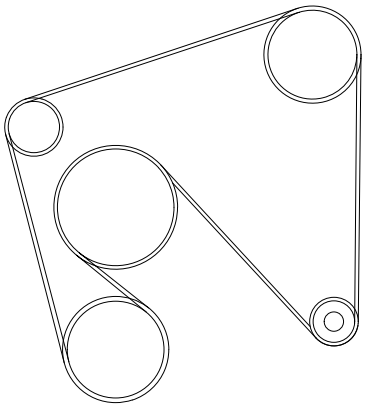
⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.

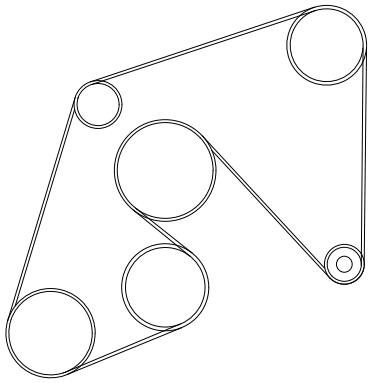
NOTE: *Some models will have components arranged in a different order. All configurations are not shown. Checking, replacing and adjustment procedures are the same.*

Serpentine Belt Routing

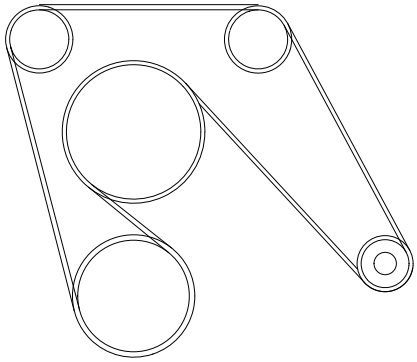
S/N 0L619083 and Below



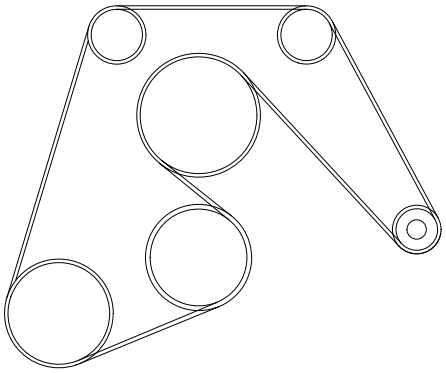
Alpha With Power Steering



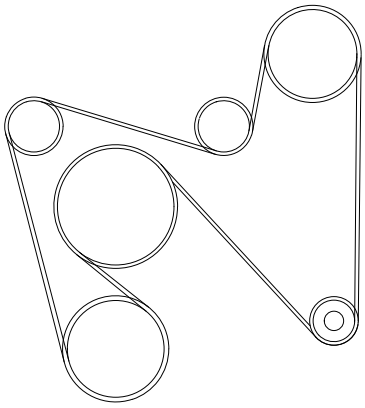
Bravo With Power Steering



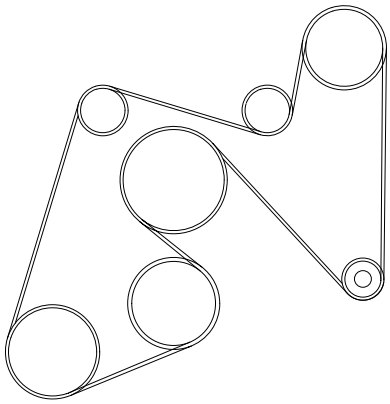
Alpha With Closed Cooling Without Power Steering



Bravo Without Power Steering



Alpha With Closed Cooling and Power Steering



Bravo With Closed Cooling and Power Steering

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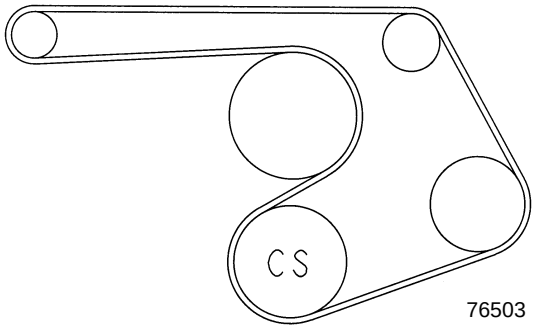
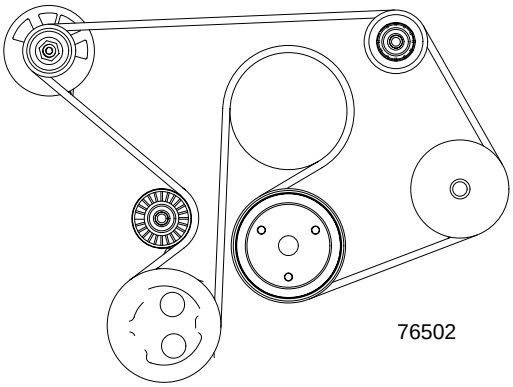
Serpentine Belt Routing (Continued)

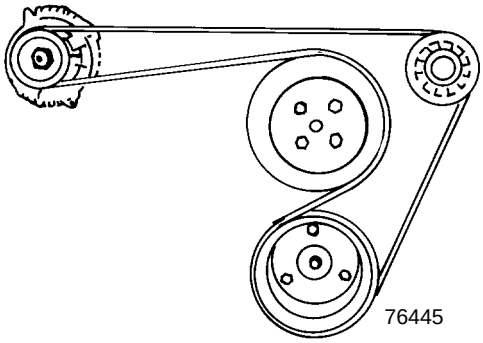
S/N 0L619084 and Above



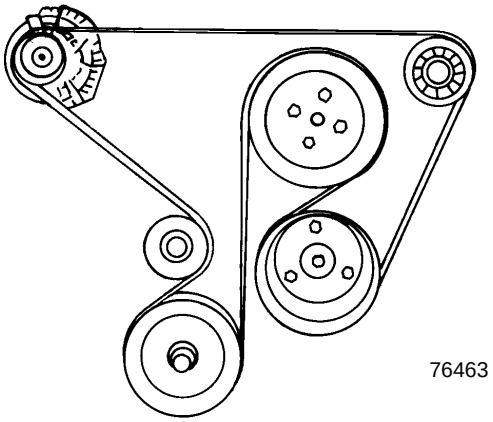
Alpha With Power Steering



Bravo With Power Steering



Alpha Without Power Steering



Bravo Without Power Steering

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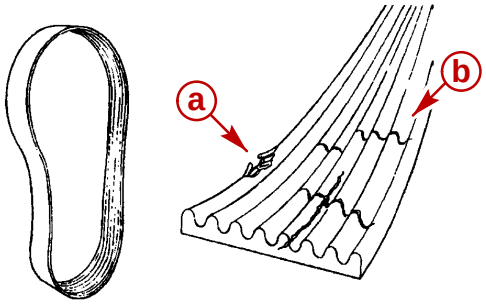
Inspection

1. Inspect drive belt for the following:

- Excessive wear
- Cracks

NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in direction of belt length) that join transverse cracks are NOT acceptable.

- Fraying
- Glazed surfaces



75130

a - Fraying
b - Cracks

Replacing and/or Adjusting Tension

REMOVAL

1. Loosen 5/8 in. locking nut on adjustment stud.
2. Turn adjustment stud and loosen belt.
3. Remove drive belt.

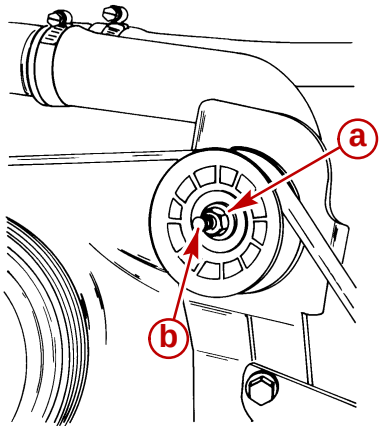
INSTALLATION AND ADJUSTMENT

4. Install drive belt on pulleys.
5. Adjust tension by loosening 5/8 in. locking nut on adjustment stud. Leave wrench on adjustment stud.

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Proper tension is 1/4 in. (6 mm) deflection with moderate thumb pressure.*

6. Use 5/16 in. socket and tighten adjusting stud until the correct deflection of the belt is obtained at location specified above.

7. While holding adjustment stud at the correct belt tension, tighten 5/8 in. locking nut.
8. Run engine for a short period of time and recheck belt adjustment.



74908

a - 5/8 in. Locking Nut
b - 5/16 in. Adjusting Stud

Ignition Timing

Thunderbolt V Models

1. Connect timing light to number 1 spark plug wire.
2. Connect a shop tachometer to the engine.

IMPORTANT: Before starting the engine, connect a jumper wire from the ignition timing lead to a good ground. This has to be done before the ignition key is turned ON to lock the ignition module into Base Timing Mode.

3. Before starting the engine, connect jumper wire from timing lead to a good ground.

NOTE: *The PUR/WHT timing lead is located towards the front of the engine near the fuel line or near the distributor, as equipped for your model.*

4. Start engine and run at 1300 rpm until it reaches normal operating temperature.
5. Disconnect throttle cable from the carburetor.
6. With engine at idle rpm, adjust the carburetor idle rpm screw to the specified engine idle rpm.
7. With the engine still at idle rpm, check the ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
8. Adjust the idle mixture screw. Inward is LEAN, outward is RICH.
9. Recheck ignition timing.
10. Stop engine. Remove timing light, jumper wire and shop tachometer.

IMPORTANT: Timing jumper wire has to be removed or the ignition module will stay locked in the Base Timing Mode and it will not be able to advance the ignition timing correctly when the engine rpm is increased.

11. Adjust and reinstall throttle cable. Open and close remote control throttle lever. Ensure that the carburetor throttle lever is contacting the idle rpm adjusting screw every time.
12. Restart the engine, increase rpm to 1300 then return to idle position slowly and shut the engine off. Ensure that the carburetor throttle lever is contacting the idle rpm screw.
13. Shut engine off.

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EFI

1. Connect timing light to number 1 spark plug wire.
2. Start engine and run at 1300 rpm until it reaches normal operating temperature.
3. Stop engine and connect the scan tool or timing tool to the DLC connector on the EFI wiring harness.
4. Start engine, allow rpm to stabilize.

NOTE: *MEFI-1 models only, manually adjust remote control throttle lever to get 1200 engine rpm.*

NOTE: *MEFI-3 models only, ECM will automatically adjust engine rpm to approximately 1200 rpm when put in the service mode on a scan tool or when using the timing tool.*

5. Check ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
6. Recheck ignition timing.
7. Disconnect scan tool or timing tool from DLC connector.
8. If required, return remote control throttle lever to idle position and shut off engine.
9. Restart engine, increase rpm to 1300 then return to idle position slowly. Ensure that engine returns to idle rpm. Readjust throttle cable, if required.
10. Shut engine off.

Cold Weather or Extended Storage

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark and/or open flames in the area. Wipe up any spilled fuel immediately.

⚠ WARNING

Avoid Fire or Explosion: To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠ WARNING

Avoid Fire or Explosion: Fuel injection system is pressurized during operation. Use care when removing water separating fuel filter. Fuel could spray on hot engine causing fire or explosion. Allow engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it to help avoid fuel spraying on the engine.

⚠ CAUTION

If boat is in the water, seacock (water inlet valve), if equipped, must be closed until engine is to be restarted, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting engine.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

⚠ CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

⚠ CAUTION

A discharged battery can be damaged by freezing.

Index

⚠ CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

⚠ WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠ CAUTION

DO NOT run engine above 1500 rpm, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠ WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting during storage, reinstall drain plugs. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

Power Package Layup

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

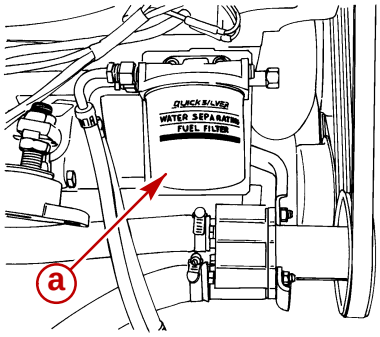
IMPORTANT: Mercury MerCruiser strongly recommends that this service be performed by an Authorized Mercury MerCruiser Dealer. Damage caused by freezing IS NOT covered by the MerCruiser Limited Warranty.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat gasoline. Follow instructions on container.
2. **If boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to “Fuel Requirements” for additional information.

NOTE: *If desired, a portable fuel tank can be used to perform the remainder of the power package layup procedures. Be sure to add an appropriate amount of Gasoline Stabilizer to the portable tank.*

3. Run engine sufficiently to bring it up to normal operating temperature and allow fuel with Quicksilver Gasoline Stabilizer to circulate through fuel system.
4. Shut off engine.
5. Change oil and oil filter.
6. Flush cooling system. Refer to “Flushing Cooling System” procedure.
7. Close the fuel shutoff valve, if equipped. If no fuel shutoff valve is present, a suitable method must be employed to STOP the flow of fuel from the fuel tank to the engine before proceeding.

8. Prepare EFI fuel system for extended storage as follows:
   a. Allow engine to cool down.
   b. Remove the water separating fuel filter.
   c. Pour out a small amount of fuel into a suitable container, then add approximately 2 fluid ounces (60 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the water separating fuel filter.
   d. Reinstall water separating fuel filter.
   e. Start and operate engine at idle speed until the water separating fuel filter and fuel injection system are empty and engine stops.
   f. Remove and discard water separating fuel filter.
   g. Install new filter.



75533

a - Water Separating Fuel Filter

9. Prepare carbureted fuel system for extended storage as follows:
   a. Remove flame arrestor assembly and start engine.
   b. While operating engine at fast idle (1000-1500 rpm), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores.
   c. Squirt the remaining 2 ounces (57 g) of Storage Seal (or oil) rapidly into carburetor, just as the engine begins to stall due to lack of fuel. Allow engine to stop.
10. Turn ignition key to OFF position.
11. Refer to “Flushing Cooling System” and appropriately remove water supply to the seawater pickup pump.
12. Clean flame arrestor and crankcase ventilation hoses and reinstall.
13. Lubricate all items listed in “Lubrication” section.
14. Drain seawater section of cooling system as outlined in “Draining Instructions” section.
15. **On Models with Closed Cooling System:** Test coolant to ensure that it will withstand the lowest temperature expected during storage.
16. Service batteries per manufacturer’s instructions.
17. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
18. For sterndrive unit layup, refer to appropriate sterndrive service manual.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

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Draining Instructions

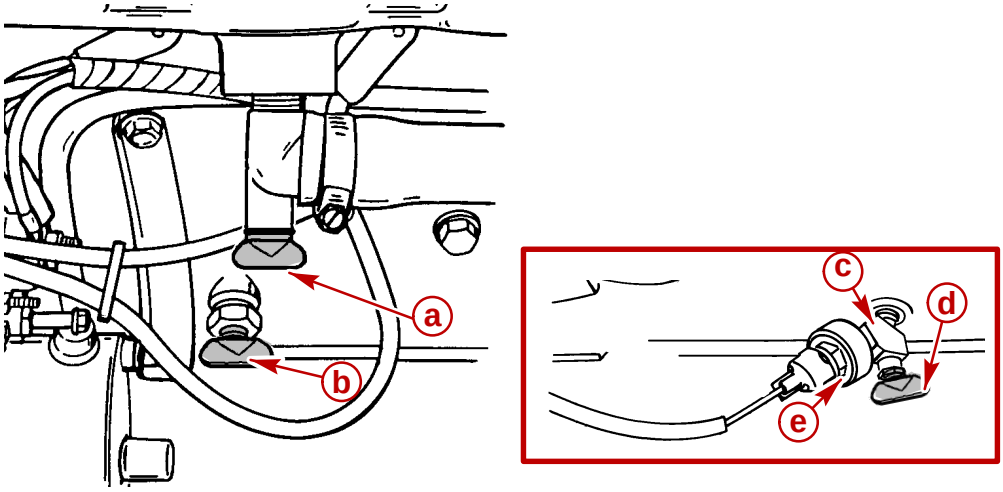
DRAINING SEAWATER (RAW-WATER) COOLED MODELS

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

1. Remove drain plugs from bottom of port and starboard manifold fittings.
2. Remove drain plugs (port and starboard) from cylinder block or cylinder block Y-fitting.

⚠ CAUTION
Avoid product damage. Do not disturb the Y-fitting when removing the drain plug. There is an ignition control “Knock Sensor” in the upper hole of the fitting. This sensor must not be loosened or removed. It is tightened to a critical specification at the factory.



74073

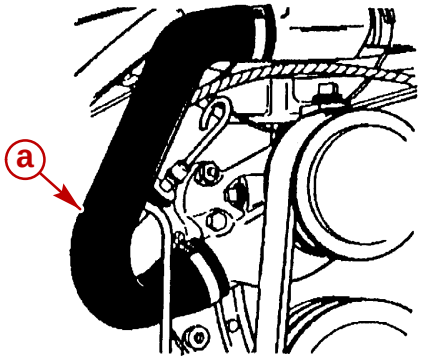
Starboard Side Shown (Port Similar)

- **a** - Exhaust Elbow Drain Plug
- **b** - Cylinder Block Drain Plug
- **c** - Y-Fitting (Fuel Injected Only)
- **d** - Cylinder Block Drain Plug (Fuel Injected Only)
- **e** - Knock Sensor

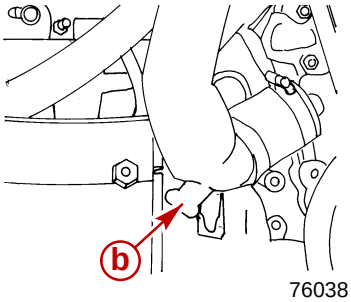
3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

4. Remove the engine water circulating pump hose or drain plug, as equipped.



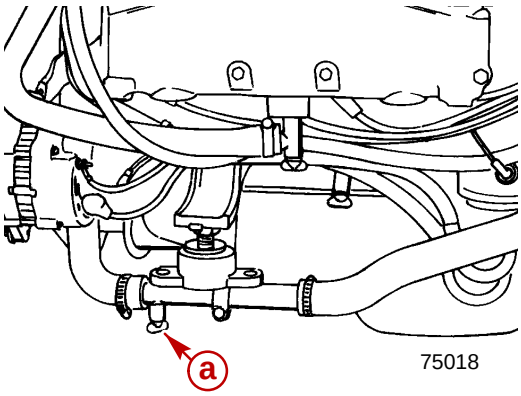
72587



76038

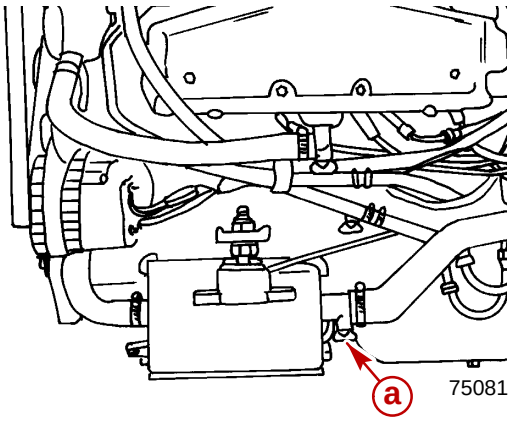
a - Hose, Water Circulating Pump To Thermostat Housing
b - Water Circulating Pump Hose Drain Plug

5. Remove the drain plug from the water tube or Cool Fuel System cooler, as equipped.



75018

Some Carbureted Models

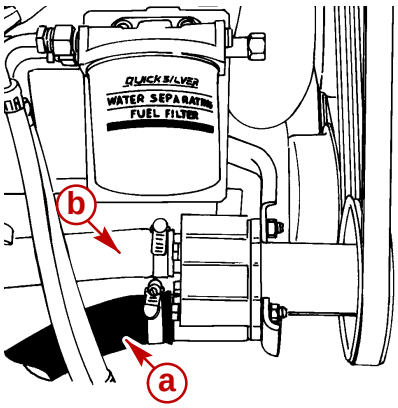


75081

Fuel Injected Models

a - Drain Plug

6. Remove seawater pump inlet hose as shown.



75533

a - Seawater Inlet Hose
b - Hose To Cooler

7. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

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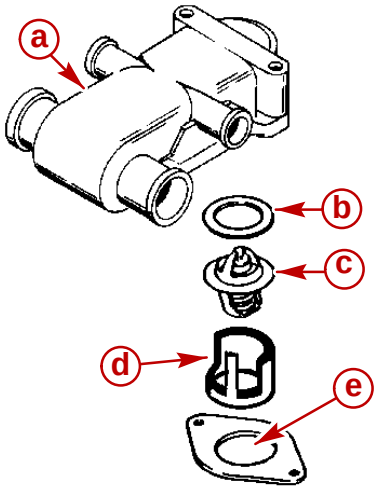
8. After seawater section of cooling system has been drained completely:
   a. Install all drain plugs and tighten securely.
   b. Reconnect hoses and tighten all hose clamps securely.
   c. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable) be used in seawater section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

9. For additional assurance against freezing and corrosion in the internal water passages:
   a. Remove the thermostat cover and thermostat.
   b. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.
   c. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb-ft (41 Nm).

NOTE: *Hoses shown removed for visual clarity. Do not remove hoses.*



74493

a - Housing
b - Gasket
c - Thermostat
d - Spacer
e - Fill Here

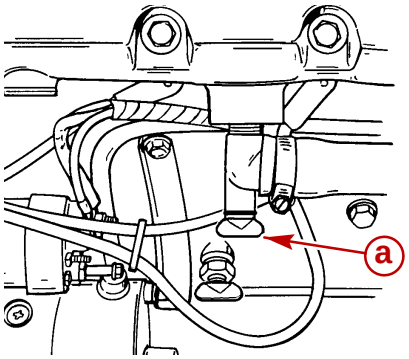
DRAINING SEAWATER SECTION OF CLOSED COOLED (COOLANT) MODELS

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

IMPORTANT: Drain seawater section of closed cooling system only.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

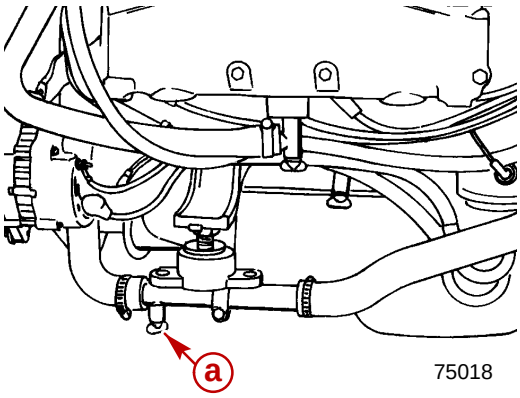
1. Remove drain plug from bottom of port and starboard exhaust manifolds.



74073

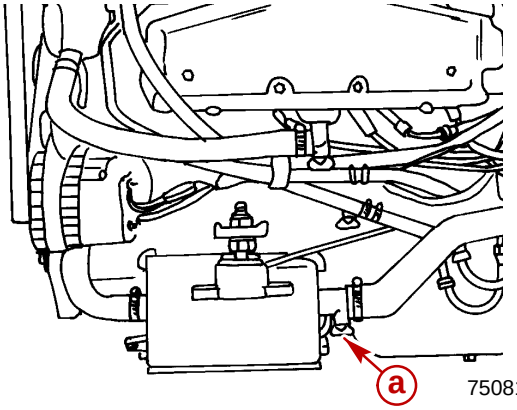
a - Drain Plug

2. Remove the drain plug from the water tube or Cool Fuel System cooler, as equipped.



75018

Some Carbureted Models



75081

Fuel Injected Models

a - Drain Plug

NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

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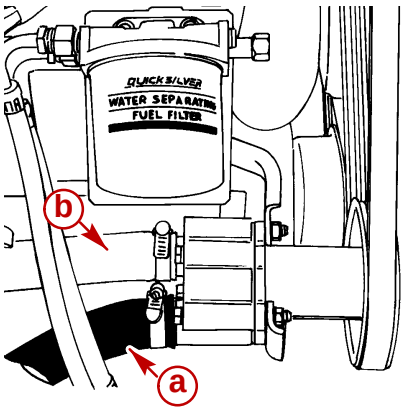
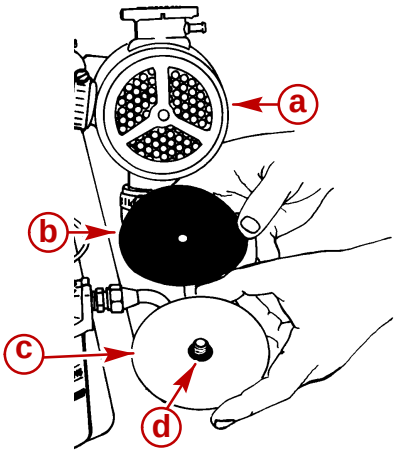
3. Remove seawater pump inlet hose.



75533

a - Seawater Inlet Hose
b - Hose To Cooler

4. Remove end caps, sealing washers and gaskets from the heat exchanger. Allow tubes to drain.



71515

a - Heat Exchanger
b - Sealing Washer
c - End Cap
d - Gasket

IMPORTANT: Use compressed air to blow any remaining water from the tubes in the heat exchanger.

5. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.
6. After seawater section of cooling system has been drained completely:
   a. Install all drain plugs and tighten securely.
   b. Reconnect hoses and tighten all hose clamps securely.
   c. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets.
   d. Assemble new gaskets, new sealing washers and end plates onto heat exchanger. Torque end plate screws to 36-72 lb-in. (4-8 Nm).
   e. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

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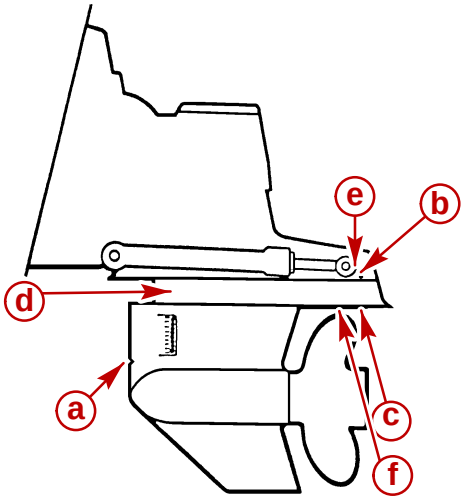
Draining Sterndrive

NOTICE
Predelivery Preparation Instructions Must Be Performed Before Delivering Boat To The Product Owner.

1. **On Bravo Drive Equipped Models:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, anode cavity vent hole and anode cavity drain passage are unobstructed and drained.

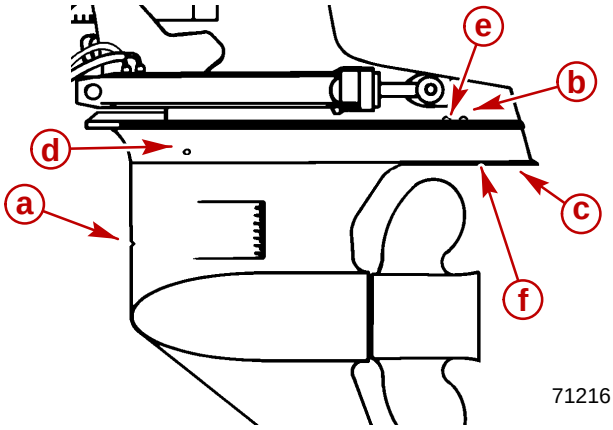


71217

Typical

- **a** - Speedometer Pitot Tube
- **b** - Anode Cavity Vent Hole
- **c** - Anode Cavity Drain Passage
- **d** - Gear Housing Water Drain Hole (One Each - Port and Starboard)
- **e** - Gear Housing Cavity Vent Hole
- **f** - Gear Housing Cavity Drain Hole

2. **On Alpha Drive Equipped Models:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, trim tab cavity vent hole and trim tab cavity drain passage are unobstructed and drained.



71216

- **a** - Speedometer Pitot Tube
- **b** - Trim Tab Cavity Vent Hole
- **c** - Trim Tab Cavity Drain Passage
- **d** - Gear Housing Water Drain Hole (One Each - Port and Starboard)
- **e** - Gear Housing Cavity Vent Hole
- **f** - Gear Housing Cavity Drain Hole

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Recommissioning

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

1. Ensure that all cooling system hoses are connected and tight.
2. Ensure all petcocks and drain plugs are installed and tight.
3. Inspect serpentine drive belt for condition and proper tension.
4. Perform all lubrication and maintenance specified for completion “Annually” and “Every 100 hours or Annually” in maintenance schedule, except items which were performed at time of engine layup.
5. For sterndrive unit recommissioning, refer to appropriate Sterndrive Service Manual.

⚠ CAUTION
When installing battery (in next step), be sure to connect positive battery cable to positive (+) terminal and negative (grounded) battery cable to negative (–) battery terminal. If battery cables are reversed, damage to electrical system WILL result.

6. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.

⚠ CAUTION
DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check steering system, shift and throttle controls for proper operation.

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IMPORTANT INFORMATION

Section 1C - Troubleshooting

1 C

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Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak. Follow specific procedures given in this manual for all fuel line connections.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠ WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark and/or open flames in the area. Wipe up any spilled fuel immediately.

⚠ WARNING

Avoid Fire or Explosion: Fuel injection system is pressurized during operation. Use care when removing water separating fuel filter. Fuel could spray on hot engine causing fire or explosion. Allow engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it to help avoid fuel spraying on the engine.

⚠ WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

⚠ WARNING

DO NOT leave helm unattended while performing idle speed adjustment.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

⚠ CAUTION

DO NOT run engine above 1500 rpm, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

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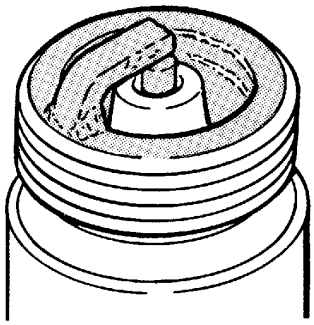
Used Spark Plug Analysis

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open electrode gap wide enough to permit cleaning and filing.
3. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.
4. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.
5. Reset gap to specifications by bending only side electrode with proper tool.

Normal Condition

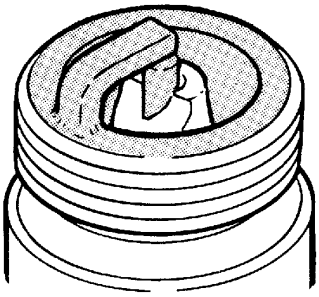
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and re-gap), this plug can be reinstalled with good results.



72420

Chipped Insulator

Chipped insulator usually results from careless plug re-gapping. Under certain conditions, severe detonation also can split insulator firing ends. Replace spark plug.

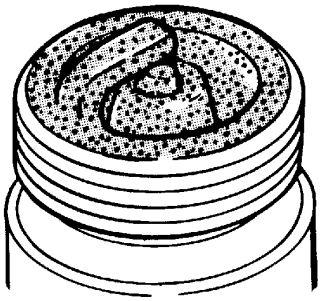


72420

Wet Fouling (Oil Deposits)

Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

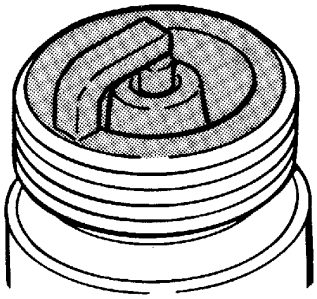
IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and re-gap) and reinstalled.



72420

Cold Fouling

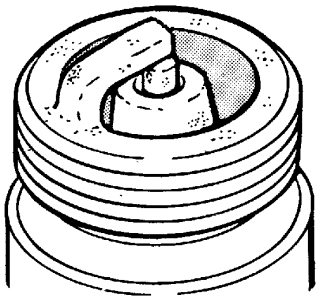
Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in set are fouled, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and re-gap) plugs and reinstall.



72421

Overheating

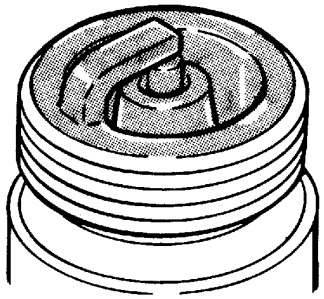
Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.



72421

High Speed Glazing

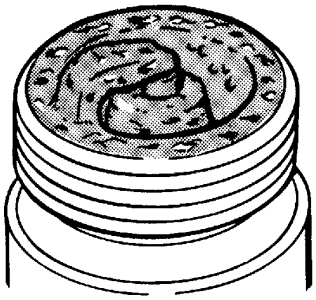
Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition recurs, use colder heat range plug and service plugs more frequently.



72421

Scavenger Deposits

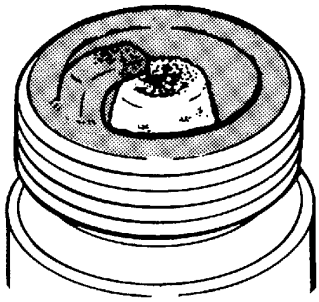
Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is normal appearance with certain branded fuels. Accumulation on ground electrodes and shell areas may be unusually heavy, but may be easily chipped off. Plugs may be serviced (clean, file and re-gap) and reinstalled.



72422

Pre-Ignition Damage

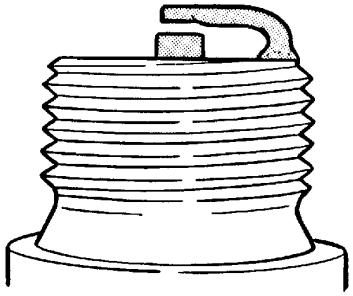
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication. Replace spark plugs.



72422

Reversed Coil Polarity

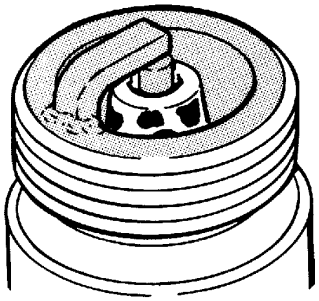
Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



72422

Splashed Deposits

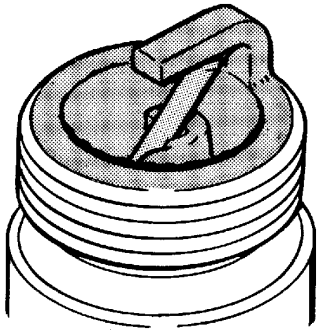
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Plugs may be serviced (clean, file and re-gap) and reinstalled.



72423

Mechanical Damage

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust material to prevent further damage. Replace spark plugs.



72423

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

Poor Boat Performance and/or Poor Maneuverability

Symptom	Cause
Bow too low	A. Improper drive unit trim angle
	B. Improper weight distribution
	C. Boat is underpowered
	D. Permanent or power hook in boat bottom
	E. False bottom full of water
	F. Improperly adjusted anode (after planes)
	G. Dirty boat bottom (marine growth)
Bow too high	A. Improper drive unit trim angle
	B. Propeller pitch too great
	C. Dirty boat bottom (marine growth)
	D. Poor running engine
	E. Improper weight distribution
	F. Rocker in boat bottom
	G. False bottom full of water
	H. Improperly adjusted anode (after planes)
Propeller ventilating	A. Drive unit installed too high on transom
	B. Dirty or rough boat bottom
	C. Damaged propeller; pitch too small; diameter too small
	D. Keel located too close to propeller or too deep in the water
	E. Water pickup or through hull fittings located too close to propeller
	F. Hook in boat bottom
	G. Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM Too High

Cause	Special Information
Propeller	Damaged; pitch too low; diameter too small; propeller hub slipping.
Boat	Water pickup or through hull fittings mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom; wrong gear ratio.
Operation	Unit trimmed out too far.
Engine coupler slipping	

RPM Too Low

Cause	Special Information
Propeller	Damaged; pitch too great; diameter too great.
Boat	Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
Operation	Unit trimmed in too far.

Engine Cranks Over But Will Not Start Or Starts Hard

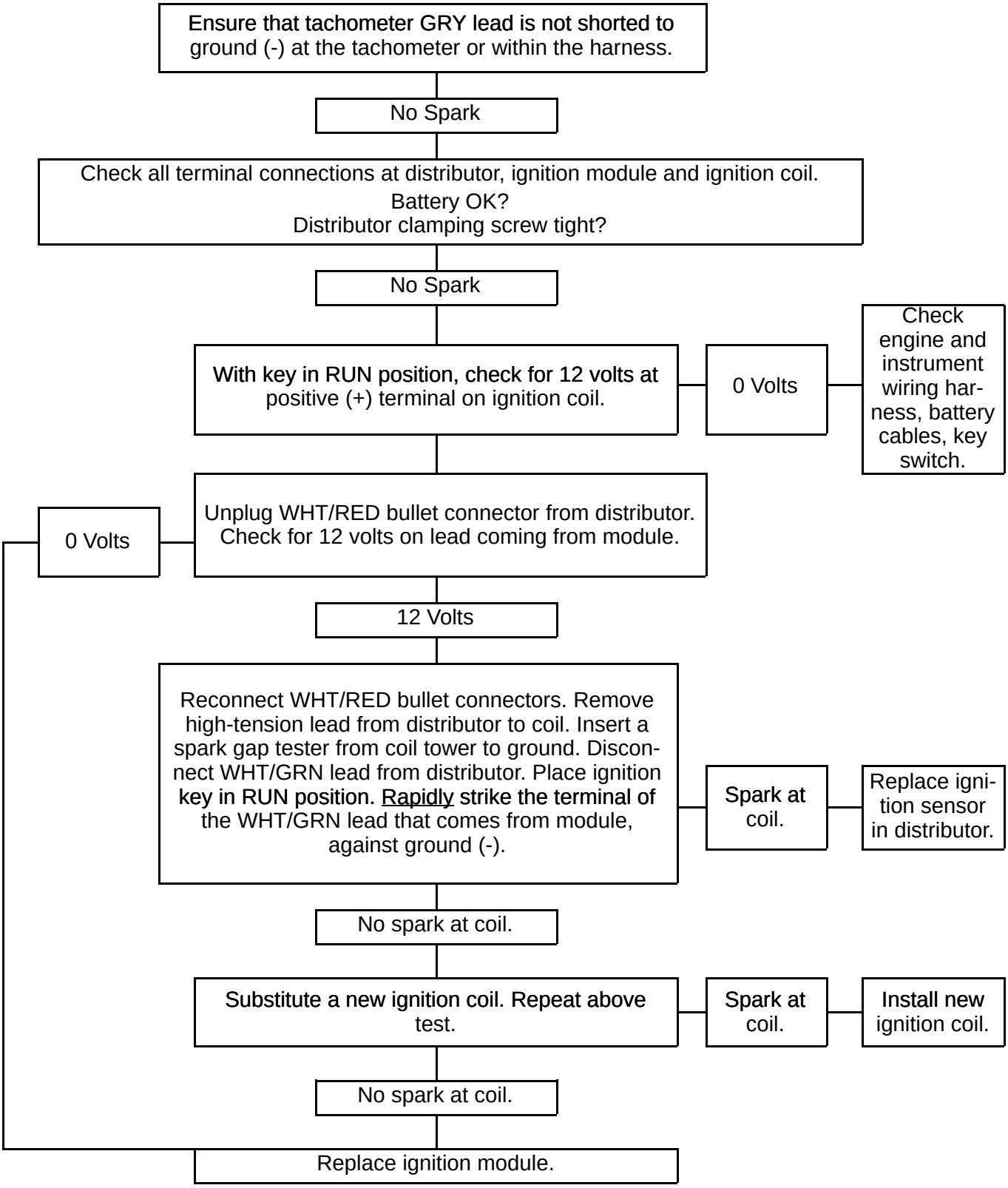
Important Information

1. First, determine which engine system is causing the problem. To make an engine run, basic components - fuel, spark (ignition), and compression - are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure they are correct type and heat range, and not fouled or burned.
3. Run a compression check on engine to make sure the engine is mechanically OK.

Thunderbolt V Ignition (No Spark)

Cause	Special Information
Moisture on ignition components	Distributor cap or spark plug wires arcing
Battery, electrical connections, damaged wiring	
Ignition switch	
Shift interrupter switch (Alpha One Models Only)	
Shorted tachometer	Disconnect tachometer and try again
Ignition timing	
Spark plugs	Fouled, burned, cracked porcelain
Spark plug wires	Faulty insulation, broken wires
Cracked or dirty distributor cap	
Faulty ignition components	Check components
Engine synchronizer (if equipped) hooked up series on purple ignition wire (dual engines only)	Synchronizers must be hooked up directly coil terminal (parallel chute)

Testing Thunderbolt V Ignition System


Ensure that tachometer GRY lead is not shorted to ground (-) at the tachometer or within the harness.
No Spark
Check all terminal connections at distributor, ignition module and ignition coil.
Battery OK?
Distributor clamping screw tight?
No Spark
With key in RUN position, check for 12 volts at positive (+) terminal on ignition coil.
0 Volts
Check engine and instrument wiring harness, battery cables, key switch.
Unplug WHT/RED bullet connector from distributor. Check for 12 volts on lead coming from module.
0 Volts
12 Volts
Reconnect WHT/RED bullet connectors. Remove high-tension lead from distributor to coil. Insert a spark gap tester from coil tower to ground. Disconnect WHT/GRN lead from distributor. Place ignition key in RUN position. Rapidly strike the terminal of the WHT/GRN lead that comes from module, against ground (-).
Spark at coil.
Replace ignition sensor in distributor.
No spark at coil.
Substitute a new ignition coil. Repeat above test.
Spark at coil.
Install new ignition coil.
No spark at coil.
Replace ignition module.

IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

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Fuel System Rich

Cause	Special Information
Clogged flame arrestor	
Excessive fuel pump pressure	
Fuel pressure regulator defective	

Fuel System Lean

Cause	Special Information
Empty fuel tank	
Fuel shut-off valve closed (if equipped)	
Vapor lock	Engine will not start after warm engine shut down

Miscellaneous

Cause	Special Information
Low grade or stale fuel	
Water in fuel	

Engine Will Not Crank Over

Cause	Special Information
Remote control lever not in neutral position	
Battery charge low; damaged wiring; loose electrical connections	
Circuit breaker tripped	
Blown fuse	
Ignition switch	
Slave solenoid	
Faulty neutral start safety switch	Open circuit
Starter solenoid	
Starter motor	
Mechanical engine malfunction	

Charging System Inoperative

Cause	Special Information
Loose or broken serpentine belt	
Engine rpm too low on initial start	Rev engine to 1500 rpm
Loose or corroded electrical connections	
Faulty battery gauge	Best way to test is to replace gauge
Battery will not accept charge	Low electrolyte or failed battery
Faulty alternator or regulator	
Refer to SECTION 4C for complete “Charging System” diagnosis procedures	

Noisy Alternator

Cause	Special Information
Loose mounting bolts	
Drive belt	Worn, frayed, loose
Loose drive pulley	
Worn or dirty bearings	
Faulty diode trio or stator	

Instrumentation Malfunction

Cause	Special Information
Faulty wiring, loose or corroded terminals	
Faulty key switch	Test, as outlined in SECTION 4D
Faulty gauge	Test, as outlined in SECTION 4D
Faulty sender	Test, as outlined in SECTION 4D

Radio Noise

Cause	Special Information
A “popping” noise that will increase with engine rpm. Noise will stop as soon as engine is turned off.	Ignition System - wrong spark plugs; cracked distributor cap; cracked coil tower; leaking spark plug wires; moisture on ignition components
“High pitched whine” in the radio	Alternator - poor brush contact on the slip rings
A “hissing or crackling” noise when instruments are jarred with ignition on	Instrumentation - loose connections, or antennae wire routed too close to instruments
Varying unexplained noises	Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. Disconnect one at a time until noise disappears.

Poor Fuel Economy

Cause	Special Information
Fuel leaks	
Operator habits	Prolonged idling; slow acceleration; failure to cut back on throttle once boat is on plane; boat overloaded; uneven weight distribution
Engine laboring	Bent, damaged, or wrong propeller. Water test boat for proper operating rpm at wide-open-throttle
Clogged flame arrestor	
Engine compartment sealed too tight	Not enough air for engine to run properly
Boat bottom	Dirty (marine growth), hook, rocker
Improper fuel	
Crankcase ventilation system not working	
Engine running too cold or too hot	
Plugged or restricted exhaust	
Engine	Low compression

Engine Runs Poorly at Idle

Symptoms	Cause
Engine surges	Refer to “Fuel Injection System Trouble-shooting,” SECTION 5H
Low top speed or lack of power	
Poor cold engine operation	
Engine stalls	
Hard starting	Refer to “Engine Starts Hard”

Engine Runs Poorly At High RPM

Cause	Special Information
Also refer to “Poor Boat Performance”	
Crankcase overfilled with oil	Check oil level with boat at rest in the water.
Anti-siphon valve (if equipped)	Restricting fuel supply
Plugged fuel tank vent	
Fuel supply	Refer to “Fuel Injection System Troubleshooting,” SECTION 5H
Ignition timing	
Low grade of fuel or water in the fuel	
Spark plugs	Fouled, burned, cracked porcelain, incorrect heat range
Spark plug wires	Poor insulation, broken wires
Distributor cap or rotor	Dirty or cracked
Coil	
Distributor	Excessive play in shaft
Engine overheating	Refer to “Engine Overheats”
Low compression	Worn valves, rings, cylinders, etc.
Restricted exhaust	

Engine Acceleration Is Poor

Cause	Special Instructions
Also refer to “Poor Boat Performance”	
Idle mixture screws	
Incorrect ignition timing	
Incorrect distributor or amplifier advance curve	Refer to SECTION 4B
Cracked or dirty distributor cap or rotor	
Vacuum leak	Intake manifold
Spark plugs	Fouled, burned; wrong heat range; cracked porcelain
Low compression	

Troubleshooting with Vacuum Gauge

Reading	Cause
Steady reading between 15-21 inches at idle rpm	Normal
Extremely low reading, but steady at idle rpm	Vacuum leak; incorrect timing; underpowered boat; faulty boat bottom
Fluctuates between high and low at idle rpm	Blown head gasket between two adjacent cylinders
Fluctuates 4 or 5 inches very slowly at idle rpm	Spark plug gap too narrow, valves are sticking
Fluctuates rapidly at idle, steadies as rpm is increased	Valve guides are worn
Continuously fluctuates between low and normal reading at regular intervals at idle rpm	Burned or leaking valve

Engine Noise

Important Information

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source. However, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine teardown is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine and drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

Valve Cover Area

Location	Possible Causes
Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	Rocker arm striking valve cover
	Rocker arm out of adjustment
	Worn rocker arm
	Bent push rod
	Collapsed lifter

Cylinder Area

Location	Possible Causes
Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	Sticking valve
	Carbon build-up
	Connecting rod installed wrong
	Bent connecting rod
	Piston
	Piston rings
	Piston pin
	Cylinder worn

Camshaft Area

Location	Possible Causes
Camshaft area, front of engine, timed to one half engine speed	Crankshaft timing sprocket
	Timing chain
	Valve Lifter
	Cam Bearings
Camshaft area, center of engine, timed to one half engine speed	Fuel Pump
	Valve Lifter
	Cam bearing
Camshaft area, rear of engine, timed to one half engine speed	Distributor gear
	Valve lifter
	Cam bearings
Camshaft area, throughout engine, timed to one half engine speed	Loss of oil pressure
	Valve lifters
	Cam bearings

Crankshaft Area

Location	Possible Causes
Crankshaft area, front of engine, timed to engine speed	Crankshaft timing sprocket
	Timing chain
	Main bearing
	Rod bearing
Crankshaft area, center of engine, timed to engine speed	Crankshaft striking pan or pan baffle
	Main bearing
	Rod bearing
Crankshaft area, rear of engine, timed to engine speed	Loose flywheel cover
	Loose coupler
	Loose flywheel
	Main bearing
	Rod bearing
Crankshaft area, throughout engine, timed to engine speed	Loss of oil pressure
	Main bearings
	Rod bearings

Miscellaneous

Noise	Possible Cause
Engine spark knock	Advanced timing
	Low octane fuel
	Engine running hot
	Carbon deposits in engine
Hissing	Vacuum leak
	Leaking exhaust (manifolds or pipes)
	Loose cylinder heads
	Blown head gasket
Whistle	Vacuum leak
	Dry or tight bearing in an accessory
Sparks jumping	Leaking high tension lead
	Cracked coil tower
	Cracked distributor cap
Squeaks or squeals	Serpentine drive belt slipping
	Dry or tight bearing in an accessory
	Parts rubbing together
Rattling in exhaust pipe area	Exhaust shutters

Oil Pressure

Miscellaneous

Cause	Special Information
Measuring oil pressure	Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
Check engine oil level with boat at rest in the water	Oil level should be between the ADD and FULL / OP RANGE / OK marks
Oil level in crankcase above FULL mark	May cause loss of engine rpm, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high rpm
Oil level in crankcase below ADD mark	Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage
Change in oil pressure	This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal opening temperature, it is normal for oil pressure to drop.
Low engine oil pressure at idle	With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not “clatter” (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will get thin somewhat from heat.
Low engine oil pressure at idle after running at a high rpm	Refer to the two preceding steps
Boats with dual engines	It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
Boats with dual stations	

Low Oil Pressure

Cause	Special Information
Low oil level in crankcase	
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge. Refer to SECTION 4D for instrument testing.
Thin or diluted oil	Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation)
Oil pump	Relief valve stuck open; pickup tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pickup oil tube
Oil leak can be internal or external	Oil passage plugs leaking, cracked or porous cylinder block
Excessive bearing clearance	Cam bearings, main bearings, rod bearings

High Oil Pressure

Cause	Special Information
Oil too thick	Wrong viscosity, oil full of sludge or tar
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge
Clogged or restricted oil passage	
Oil pump relief valve stuck closed	

Excessive Oil Consumption

Cause	Special Information
Normal consumption.	One quart of oil consumed in 5-15 hours of operation at wide-open-throttle (especially in a new or rebuilt engine) is normal
Oil leaks	Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
Oil too thin	Oil diluted or wrong viscosity
Oil level too high	
Drain holes in cylinder head plugged	Oil will flood valve guides
Defective valve seals	
Intake manifold gasket leaking	
Worn valve stems or valve guides	
Defective oil cooler (if equipped)	Crack in cooler tubes
Defective piston rings	Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
Defective cylinders	Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston
Excessive bearing clearance	

Water In Engine

Important Information

IMPORTANT: First determine location of water in engine. This information can help determine where the water came from and how it got into the engine. The three most common problems are water on top of pistons, water in crankcase oil or water in crankcase oil and on top of pistons.

After locating water remove all the water from the engine by removing all spark plugs and pumping cylinders out by cranking engine over. Change oil and filter. Replace spark plugs. Start engine and see if problem can be duplicated. If problem can be duplicated, there is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered these areas.

Water on Top of Pistons

Cause	Special Information
Operator shut engine off at high rpm	
Engine “diesels” or tries to run backwards	Poor fuel, high idle rpm, timing set too high
Rain water running into flame arrestor	Hatch cover
Spark plug misfiring	Improper combustion causes moisture in the air to accumulate in the cylinder
Backwash through the exhaust system	
Improper engine or exhaust hose installation	
Cracked exhaust manifold	
Improper manifold to elbow gasket installation	
Loose cylinder head bolts	
Blown cylinder head gasket	Check for warped cylinder head or cylinder block
Cracked valve seat	
Porous or cracked casting	Check cylinder heads, cylinder block, and intake manifold

Water in Crankcase Oil

Cause	Special Information
Water in boat bilge	Boat has been submerged or bilge water was high enough to run in through dipstick tube
Water seeping past piston rings or valves	Refer to “Water in Engine” (“On Top of Pistons”)
Engine running cold	Defective thermostat, missing thermostat; prolonged idling in cold water
Intake manifold leaking near a water passage	
Cracked or porous casting	Check cylinder head, cylinder block, and intake manifold

Engine Overheats

Mechanical

Cause	Special Information
Engine rpm below specifications at wide-open-throttle (engine laboring)	Damaged or wrong propeller; growth on boat bottom; false bottom full of water
Wrong ignition timing	Timing too far advanced or retarded
Sticking distributor advance weights	
Spark plug wires crossed (wrong firing order)	
Lean fuel mixture	
Wrong heat range spark plugs	
Exhaust restriction	
Valve timing off	Jumped timing chain, or improperly installed
Blown head gasket(s)	A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low rpm, but will overheat at speeds above 3000 rpm. **Engines that are seawater cooled**: Using a clear plastic hose, look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose between thermostat housing and manifold(s). If air bubbles are present at a higher rpm, it is a good indication there is a blown head gasket.
Insufficient lubrication to moving parts of engine	Defective oil pump, plugged oil passage, low oil level

Engine Overheats

Cooling System

Cause	Special Information
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty. **IMPORTANT: Best way to test gauge or sender is to replace them.**	
Loose or broken drive belt	
Seawater shutoff valve partially or fully closed (if equipped)	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet (models with belt driven seawater pump only)	Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
Seawater inlet hose kinked or collapsed	
Seawater pickup clogged	
Obstruction on boat bottom causing water turbulence	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Defective thermostat	
Exhaust elbow water outlet holes plugged	
Insufficient seawater pump operation	Worn pump impeller
Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	Refer to water flow diagram for engine type being serviced
Engine circulating pump defective	
Also refer to “Engine Overheats - Mechanical”	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
Low coolant level	
Antifreeze not mixed properly	Antifreeze should be mixed 50/50 or maximum 60/40 (60% antifreeze, 40% water)
Heat exchanger cores plugged	
Water hoses reversed at the water distribution block	Refer to water flow diagram in SECTION 6

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Insufficient Water Flow from Belt Driven Seawater Pickup Pump

Cause	Special Information
Drive belt	Loose, worn or broken
Seawater shutoff valve partially or fully closed	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet	Pump will suck air, pump may fail to prime or will force air bubbles into cooling system
Seawater inlet hose kinked or plugged	
Seawater pickup plugged	
Obstruction on boat bottom causing water turbulence.	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Faulty seawater pump	

Power Steering

Poor, Erratic or No Assist

Cause	Special Information
Drive belt	Worn, broken or out of adjustment
Low fluid level	
Air in system	Air leak in lines, pump or air from installation. Refer to SECTION 9A for bleeding procedure.
Leaking hoses	Refer to SECTION 9A for bleeding procedure.
Steering cables and/or steering helm	Cable or helm partially frozen from rust or corrosion; cable over-lubricated; improper cable installation.
Binding in sterndrive unit	Refer to appropriate Sterndrive Service Manual
Restriction in hydraulic hoses	Causes a loss of pressure
Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
Mounting bracket adjusting screw loose or mounting tube is loose	
Faulty pump	Flow control valve may be sticking
Worn piston ring or scored housing bore in cylinder.	Causes loss of pressure
Leaking valve body or loose fitting spool	

Noisy Pump

Cause	Special Information
Drive belt	Check belt tension
Low fluid level	
Air in fluid	Air leak in lines, pump or air from installation
Faulty pump	Use stethoscope to listen for noise in pump
Restricted fluid passages	Kinks or debris in hoses or debris in passages
Stop nut adjusted improperly	Refer to appropriate Sterndrive Service Manual
Steering cables installed that do not meet BIA standards	Refer to appropriate Sterndrive Service Manual

Fluid Leaks

Cause	Special Information
Loose hose connections	Refer to SECTION 9A for bleeding instructions
Damaged hose	
Oil leaking from top of pump	System overfilled; fluid contains water; fluid contains air
Cylinder piston rod seal	
Faulty seals in valve	
Faulty seals in o-rings in pump	
Cracked or porous metal parts	

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REMOVAL AND INSTALLATION

Section 2A - MCM Models

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Torque Specifications

Fastener Location		lb-in.	lb-ft	Nm
Drive Unit Shift Cable	Cable Barrel	Spread Cotter Key		
	Cable End Guide	See Note		
Hose Clamps		Securely		
Rear Engine Mounts			35-40	47-54
Power Steering Fluid Hose Fitting			23	31
Remote Control Shift Cables	Cable Barrel	Securely		
	Cable End Guide	See Note		

NOTE: *Tighten, then loosen nut 1/2 turn.*

Tools

Description	Part Number
Engine Alignment Tool	91-805475A1

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Engine Coupler Spline Grease	91-816391A4
Quicksilver Liquid Neoprene	92-27511-2
Loctite 592 Pipe Sealant With Teflon	Obtain Locally

Removal

IMPORTANT: Sterndrive unit must be removed prior to engine removal. Refer to Sterndrive Service Manual.

1. Disconnect battery cables from battery.
2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass filter nut at fuel inlet, loosen fuel line fitting. Disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor or throttle body and retain locknuts and hardware.
5. Disconnect trim sender bullet connectors from transom assembly from engine harness.

NOTE: *After wires are disconnected be sure to loosen them from clamps or sta-straps retaining them to engine or hoses.*

6. **Alpha Models:** Slide sleeves back on BLK and WHT/GRN or GRY wires and disconnect engine harness wires from shift cut-out switch harness.
7. Disconnect MerCathode wires from MerCathode controller if mounted on engine, if equipped.
8. Disconnect seawater inlet hose from gimbal housing.
9. Disconnect exhaust elbow hoses (bellows).
10. Remove both shift cables from shift plate. Retain locknuts and hardware.
11. Disconnect any grounding wires and accessories connected to engine.
12. Disconnect and plug fluid hoses from power steering control valve on transom.

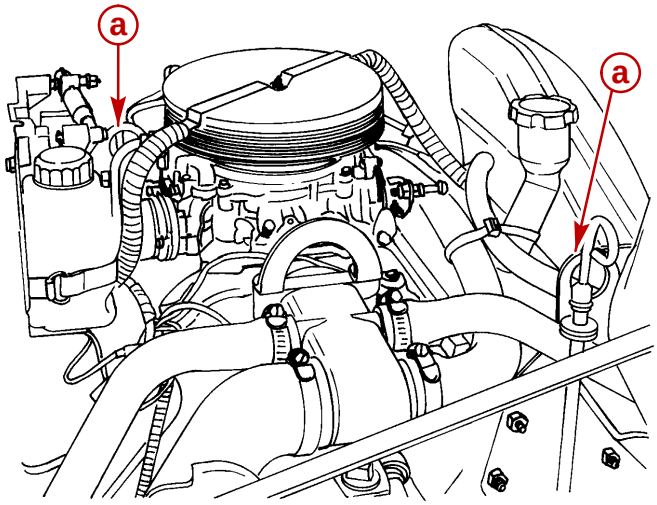
⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

13. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts. Retain hardware.



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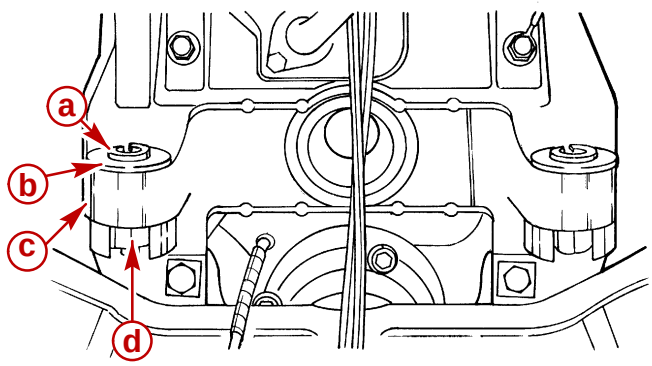
a - Engine Lifting Eyes

14. Carefully remove engine. DO NOT hit power steering control valve.

Installation and Alignment

1. Inspect fiber washers (cemented in place) on inner transom plate. Replace if worn or damaged.
2. Install double wound lockwashers onto inner transom plate inside fiber washer.
3. Ensure that rear engine mount locknuts are in position.
4. Lubricate exhaust bellows with soap and water to ease installation.
5. Lubricate engine coupler splines with Quicksilver Engine Coupler Spline Grease.



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a - Double Wound Lockwasher
b - Fiber Wound Lockwasher (Cemented In Place)
c - Inner Transom Plate Mount (Engine Support)
d - Locknuts (Engine Mounting Bolts)

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

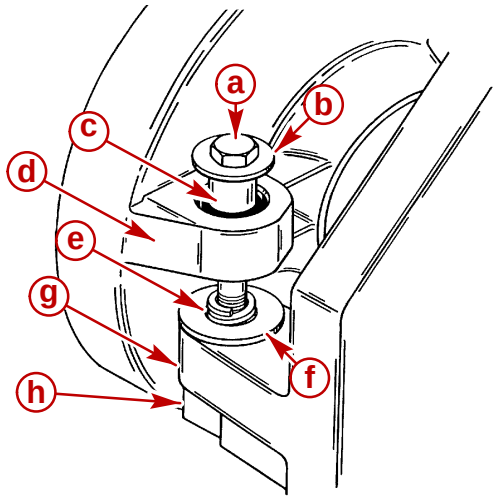
⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

6. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended.
7. Lift engine into position (in boat), using an overhead hoist.
8. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses (bellows).

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

9. Install both rear engine mounting bolts and hardware as shown. Torque to 37 lb-ft (50 Nm).



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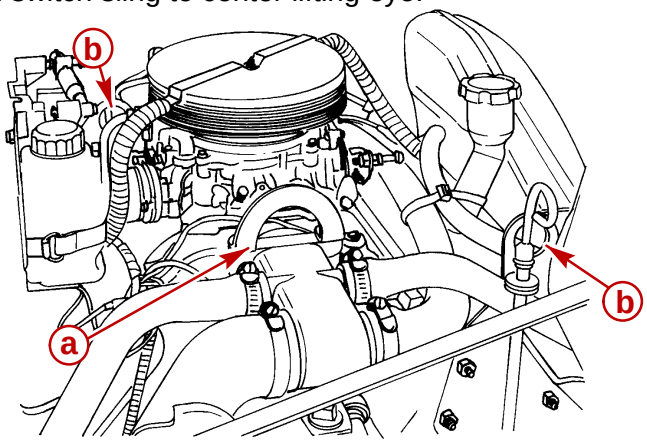
a - Rear Engine Mounting Bolt
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer (Cemented in Place)
g - Inner Transom Plate Mounts
h - Locknut (Hidden In This View)

⚠ CAUTION

When lowering engine into position DO NOT set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

10. Set engine down on stringers and relieve hoist tension. Disconnect sling from engine lifting eyes and switch sling to center lifting eye.



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a - Center Lifting Eye
b - Engine Lifting Eyes

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⚠ CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool 91-805475A1, may cause improper alignment and damage to gimbal bearing and/or engine coupler.

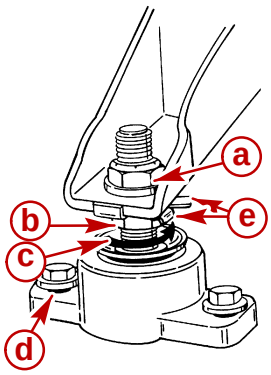
⚠ CAUTION

To avoid damage to gimbal bearing, engine coupler, or alignment tool:

- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**

⚠ CAUTION

Avoid damage to exhaust system. On engines with single piece manifolds, stress can be placed on the lower exhaust pipe if front of engine is raised too high while performing engine alignment procedure. Ensure that engine is not raised higher than the top of engine mount adjusting stud.



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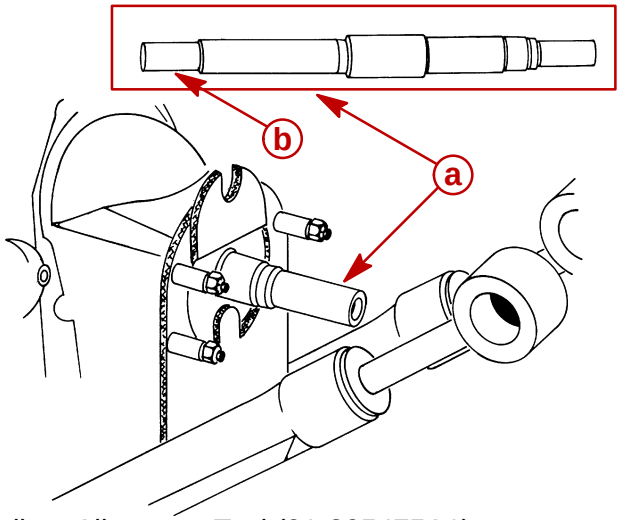
Engine Mount

- **a** - Nut and Lockwasher
- **b** - Adjustment Nut
- **c** - Turn Adjustment Nut in This Direction (Counterclockwise)
- **d** - Slotted Hole Toward Front of Engine
- **e** - Tab Washer

11. Align engine as follows:

    a. Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines. If it will not insert easily proceed to following.

    b. While observing the above precautions, CAREFULLY raise and lower front of engine with hoist, as required, until tool will SLIDE FREELY all the way in and out of engine coupler splines.



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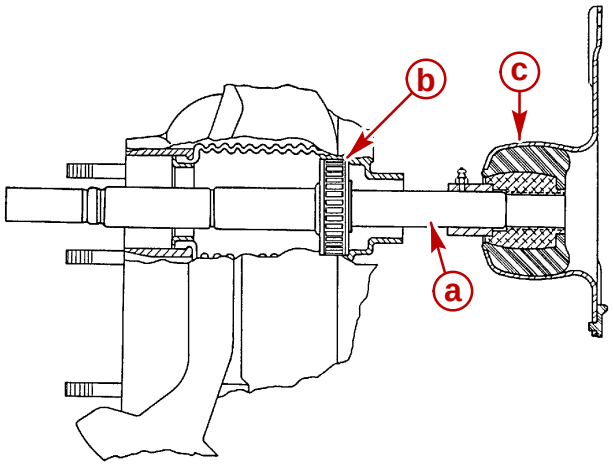
a - Quicksilver Alignment Tool (91-805475A1)
b - Insert This End of Alignment Tool through Gimbal Housing Assembly



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a - Alignment Tool (91-80547A1)
b - Gimbal Bearing
c - Engine Coupler

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

    c. Adjust front engine mounts until they rest on boat stringers.

    d. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware (lag bolts or through-bolts, etc.).

    e. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.

    f. When alignment is correct, tighten locknut or nut with lockwasher on each mount securely.

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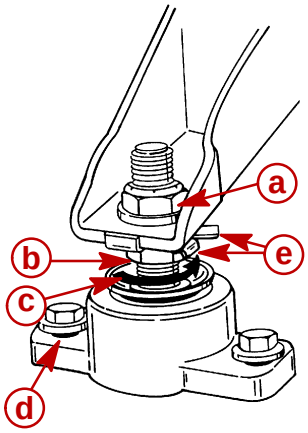
g. Bend tab washer down against flat on adjusting nut.



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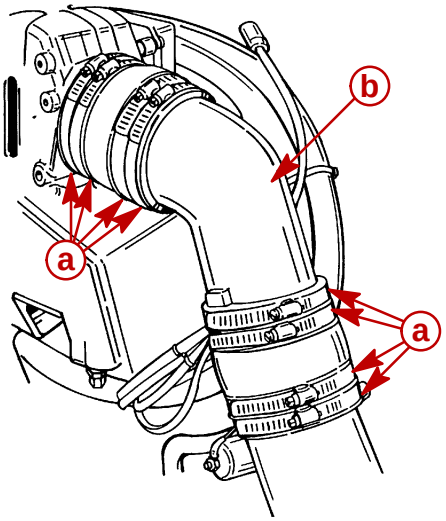
a - Locknut
b - Adjustment Nut
c - Turn Adjustment Nut In This Direction (Counterclockwise) To Raise Front Of Engine
d - Slotted Hole To Front Of Engine
e - Tab Washer

h. Remove alignment tool if not already removed.

12. Tighten all exhaust system hose clamps securely (use two hose clamps on each connection):

a. **On Engines with Thru-Prop Exhaust:**



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Thru Prop Exhaust Shown

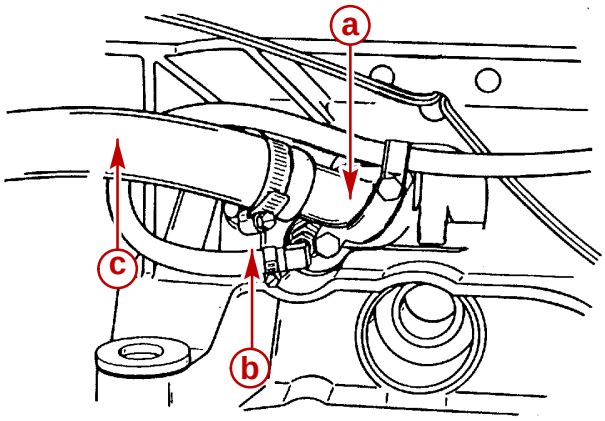
a - Hose Clamps
b - Exhaust Tube - Long Tube, Port Side - Short Tube, Starboard Side

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.

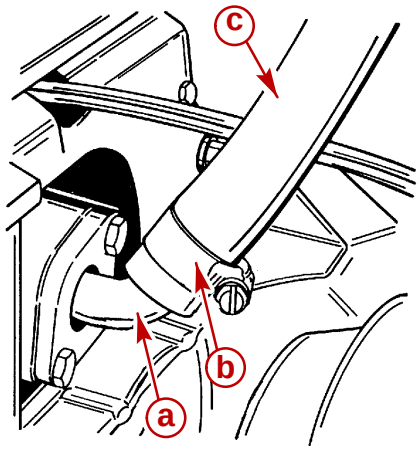
NOTE: *For visual clarity the engine is not shown in position.*



72590

Bravo Models

a - Water Inlet Tube
b - Hose Clamp
c - Seawater Inlet



72614

Alpha Models

a - Water Inlet Tube
b - Hose Clamp
c - Seawater Inlet

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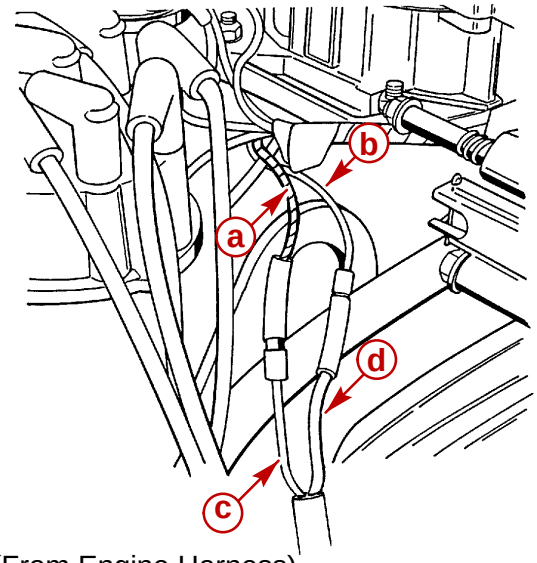
Electrical Connections

1. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.
2. Connect trim position sender leads from gimbal housing to leads from engine harness.



72582

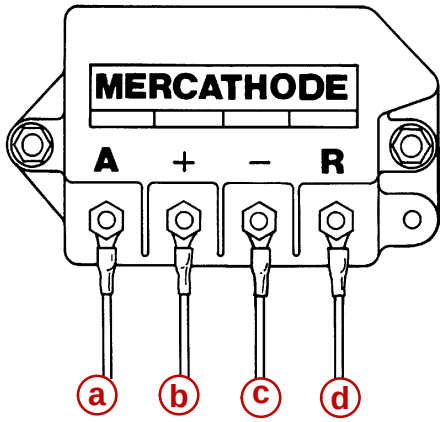
a - BRN/WHT (From Engine Harness)
b - BLK (From Engine Harness)
c - BLK (From Transom)
d - BLK (From Transom Assembly)

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

3. Connect any grounding wires or accessories that may have been disconnected.

Mercathode Connections (if equipped)

1. Connect MerCathode wires to MerCathode controller assembly. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



22232

a - ORG Wire - From Electrode on Transom Assembly
b - RED/PUR Wire - To Positive (+) Battery Terminal
c - BLK Wire - From Engine Harness
d - BRN Wire - From Electrode on Transom Assembly

IMPORTANT: Adjust shift cables as outlined in appropriate Sterndrive Service Manual.

Shift Cable Installation

1. Refer to appropriate Sterndrive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

Power Steering Connections

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" or refer to appropriate Sterndrive Service Manual.

1. Connect power steering fluid hoses to control valve (large fitting first).

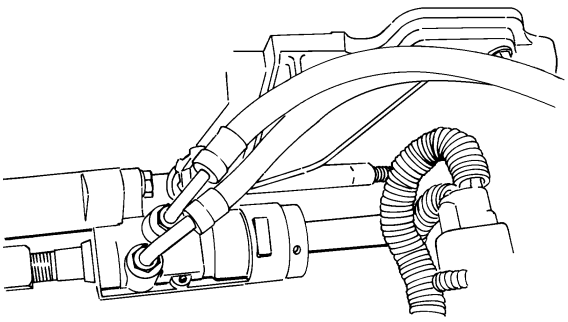
⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: DO NOT cross-thread or overtighten fittings.

2. Torque both fittings to 23 lb-ft (31 Nm).



73786

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3. Connect battery cables to battery by FIRST connecting POSITIVE (+) battery cable (usually RED) to POSITIVE (+) battery terminal. Tighten clamp securely. Then, connect NEGATIVE (–) battery cable (usually BLK) to NEGATIVE (–) battery terminal. Tighten clamp securely.

NOTE: *Spray terminals with a battery connection sealant to help retard corrosion.*

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER TIGHTEN.**
- **Install fuel line. To prevent over tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠ WARNING

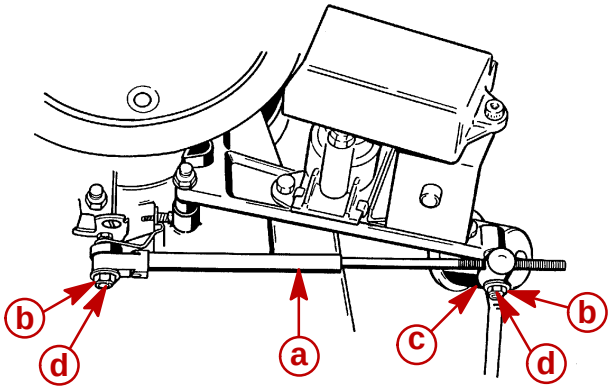
Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

1. Connect fuel line from fuel tank(s) to engine. Tighten connections securely.
2. Check for leaks.

Throttle Cable Installation and Adjustment

1. Connect throttle cable using hardware retained and adjust as follows:

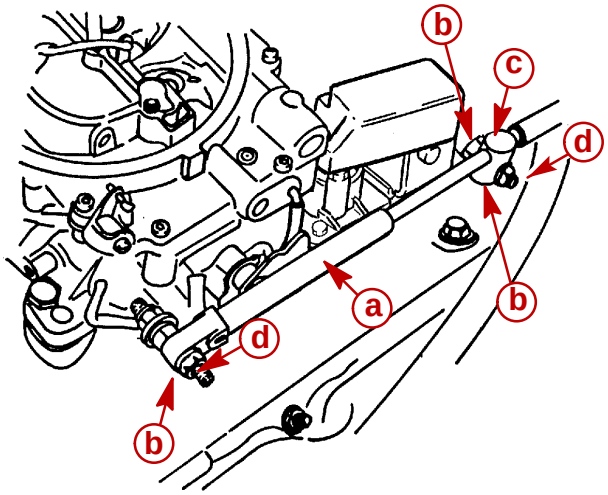
CARBURETED ENGINES



72013

MerCarb 2 Barrel Carburetor

- **a** - Cable End Guide
- **b** - Attaching Hardware
- **c** - Cable Barrel
- **d** - Anchor Studs



72014

Weber 4 Barrel Carburetor

- **a** - Cable End Guide
- **b** - Attaching Hardware (DO NOT Overtighten)
- **c** - Cable Barrel
- **d** - Anchor Studs

1. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

2. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.

3. Secure throttle cable with hardware (retained). Tighten cable end guide nut until it contracts and then loosen 1/2 turn. Tighten cable barrel securely. DO NOT OVERTIGHTEN, as cable must pivot freely.

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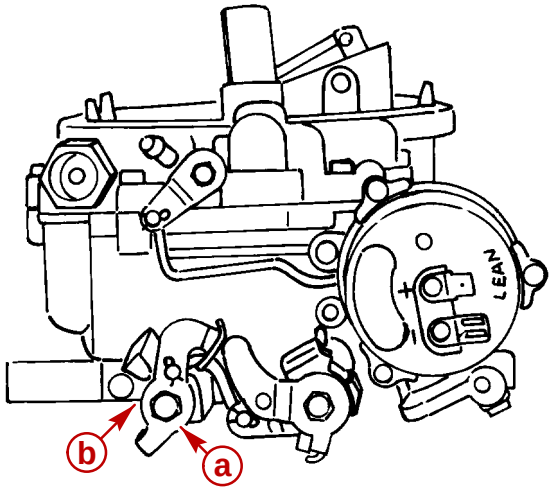
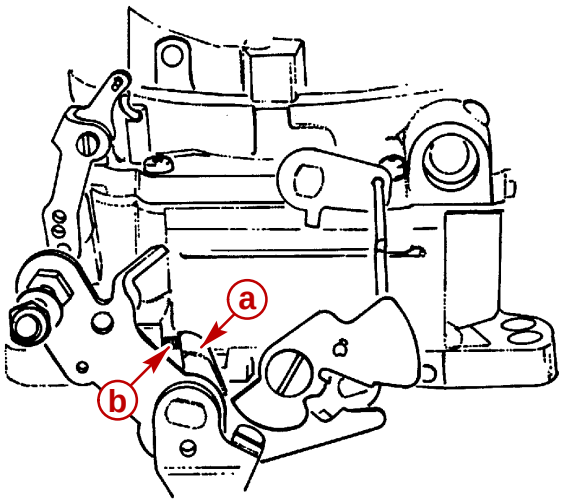
4. Place remote control throttle lever in the wide-open-throttle (WOT) position. Ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.
5. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



74104

Weber 4 Barrel Carburetor Wide-Open-Throttle

a - Throttle Shaft Lever
b - Carburetor Body Casting

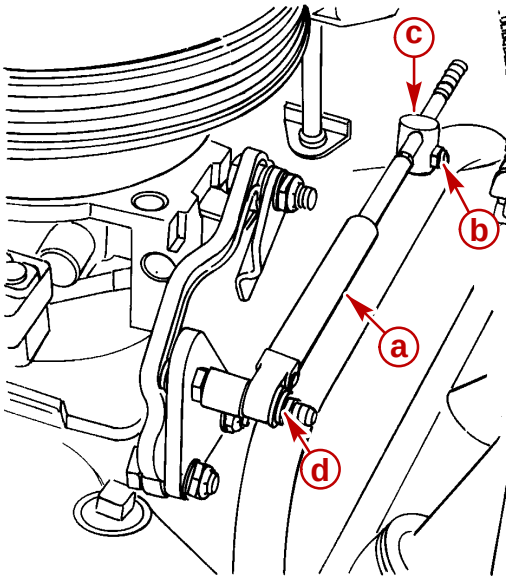


70392

Weber 4 Barrel Carburetor Idle Position

a - Throttle Lever
b - Idle Speed Adjustment Screw

1. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever). Adjust barrel on throttle cable to align with hole in anchor plate.
2. Secure throttle cable with hardware as shown and tighten securely. Tighten locknut until it contacts, then loosen one-half turn.
3. Place remote control throttle level in the wide open throttle (WOT) position. Ensure that throttle plates are completely open.
4. Return remote control throttle lever to idle position.



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a - Cable End Guide
b - Flat Washer and Locknut
c - Cable Barrel
d - Flat Washer and Locknut

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ENGINE

Section 3A - 262 cid (4.3L) Engines

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Torque Specifications 262 cid (4.3L) Engines

Description	lb-in.	lb-ft	Nm
Alternator Brace to Alternator	192		28
Alternator Brace to Engine		30	41
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
Balance Shaft Drive Gear Retaining Stud	120		14
Balance Shaft Driven Gear Bolt **(Torque Plus 35°)**		15	20
Balance Shaft Thrust Plate	120		14
Camshaft Sprocket		20	27
Camshaft Thrust Plate	106		12
Carburetor	132		15
Connecting Rod Cap Nuts **(Torque Plus 70°)**		20	27
Coupler/Flywheel		35	48
Crankcase Front Cover	124		14
Crankshaft Pulley Bolt (Cast Aluminum)		40	54
Cylinder Head Bolts - First Sequence		22	30
Angle Torque Second Sequence			
Short Bolt		55 Degrees	
Medium Bolt		65 Degrees	
Long Bolt		75 Degrees	
Distributor Hold Down		25	34
Exhaust Manifold		20	27
Flywheel		75	100
Flywheel Housing to Block		30	41
Flywheel Housing Cover	80		9
Front Mount Bracket		30	41
Fuel Filter Bracket Bolt		25	25
Fuel Pump Bracket Bolt		25	25
Fuel Pump Inlet Fitting (Large Diameter See Note)	96		10.8
Fuel Pump Inlet Fitting (Small Diameter See Note)	84		9.6
Intake Manifold Bolts		11	15
Knock Sensor		15	20

NOTE: *Hold fuel pump using flat surface at outlet before tightening brass fitting.*

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Torque Specifications 262 cid (4.3L) Engines (continued)

Description	lb-in	lb-ft	Nm
Main Bearing Cap		75	100
Oil Filter Adapter Bolts		15	20
Oil Pan Drain Plug		15	20
Oil Pan Screw (1/4-20)	80		9
Oil Pan Nuts (5/16-20)	165		19
Oil Pump		65	68
Oil Pump Cover	80		9
Power Steering Pump Brace to Block		30	41
Power Steering Pump Bracket		30	41
Rear Crankshaft Oil Seal Retainer Screws and Nuts	133		15
Rear Mount (MCM)		40	54
Rocker Arm Cover	106		12
Rocker Arm Nuts		22	30
Roller Lifter Restrictor Plate		12	16
Seawater Pump Brace (if equipped)		30	41
Seawater Pump Bracket (if equipped)		30	41
Spark Plugs		15	20
Starter Motor		50	68
Thermostat Housing		30	41
Torsional Damper		40	54
Water Circulating Pump		30	41
Water Temperature Sender		20	27

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Loctite 27131	92-809820
Quicksilver RTV Sealer	92-91601-1
Quicksilver Perfect Seal	92-34227--1
Quicksilver Needle Bearing Assembly Lubricant	92-825265A1
General Motors Cam and Lifter Prelube or Equivalent	Obtain Locally

Tools

Mercury Marine Special Tools	
Description	**Part Number**
Piston Ring Expander	91-24697
Engine Coupler Wrench	91-35547

Special Tools

Snap-On Special Tools (see note)	
Description	**Part Number**
Torque Angle Gauge (Degree Wheel Torquing)	TA 360

NOTE: *Snap-On Tools can be ordered from your nearest Snap-On branch sales office or distributor.*

Kent-Moore Special Tools	
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 (800) 345-2233	
Description	**Part Number**
Valve Spring Compressor	J5892
Valve Spring Compressor	J8062
Valve Spring Tester	J8056
Valve Guide Cleaner	J8101
Valve Guide Reamer	J5830-2
Carbon Remover Brush	J8089
Piston Pin Remover Kit	J24086-B
Piston Ring Groove Cleaner	J3936-03
Piston Ring Compressor	J8037
Connecting Rod Bolt Guide Set (3/8-24)	J5239
Oil Pump Suction Pipe Installer	J21882
Camshaft Bearing Remover and Installer Set	J6098-01
Ball Socket Adaptor Tool Kit (Lift Indicator)	J8520-1
Torsional Damper Remover and Installer	J23523-E
Crankcase Front Cover Seal Installer	J35468
Crankshaft Gear and Sprocket Puller	J5825-A
Crankshaft Gear and Sprocket Installer	J5590
Air Adaptor	J23590
Main Bearing Remover/Installer	J8080
Rear Main Seal Installer	J26817-A
Balance Shaft Rear Bearing Remover	J26941
Balance Shaft Bearing Remover/Installer	J33834

Specifications

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

Displacement	262 cid (4.3 L)
Bore	4.00 (101.6)
Stroke	3.48 (88.39)
Compression Ratio	9.2:1
Heads	Cast Iron
Intake manifold	Cast Iron
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Pistons	Cast Aluminum
Crankshaft	Cast Iron
Camshaft	Steel

CYLINDER BORE

Diameter			4.0007-4.0017 (101.6178-1016431)
Out-of-Round		Production	.0005 (0.0127) Maximum
		Service	.002 (0.05) Maximum
Taper	Production	Thrust Side	.0005 (0.0127) Maximum
		Relief Side	.001 (0.02) Maximum
	Service		.001 (0.02) Over Production

PISTON

Clearance	Production	.0007-.002 (0.017 - 0.05)
	Service	.002 (0.60) Maximum

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

PISTON RING

Compression	Groove Side Clearance	Production	Top	.02-.06 (0.508-1.524)
			2nd	.04-.08 (1.016-2.032)
		Service		.004 (0.10) Maximum
	Gap	Production	Top	.010-.016 (0.25-0.40)
			2nd	.018-.026 (0.46-0.66) Maximum
		Service		.06-.035 (1.52-0.88) Maximum
Oil	Groove Side Clearance	Production		.02-.07 (0.508-0.177)
		Service		.02-.08 (0.50-2.03) Maximum
	Gap	Production		.015-.050 (0.381-1.27)
		Service		.009-.065 (0.23-1.65) Maximum

PISTON PIN

Diameter		.9267-.9271 (23.545-23.548)
Clearance in Piston	Production	.0002-.0007 (0.0051-0.0177)
	Service	.001 (0.02) Maximum
Fit in Rod		.0008-.0016 (0.021-0.040) Interference

262 CID / 4.3L Engine Specifications

CRANKSHAFT

NOTICE
Unit Of Measurement: Inches (Millimeters)

Main Journal	Diameter	No. 1	2.4488-2.4495 (62.199-62.217)
		No. 2, 3	2.4485-2.4494 (62.191-62.215)
		No. 4	2.4479-2.4489 (62.179-62.203)
	Taper	Production	.0003 (0.007) Maximum
		Service	.001 (0.02) Maximum
	Out-of-Round	Production	.0002 (0.005) Maximum
		Service	.001 (0.02) Maximum
Main Bearing Clearance	Production	No. 1	.0008-.0020 (0.0203-0.0508)
		No. 2, 3, 4	.0011-.0023 (0.0279-0.0584)
	Service	No. 1	.001-.002 (0.03-0.05)
		No. 2, 3, 4	.001-.002 (0.25-0.06)
Crankshaft End Play			.002-.008 (0.05-0.20)
Crankshaft Runout			.001 (0.025) Maximum
Connecting Rod Journal	Diameter		2.2487-2.2497 (57.1170-57.1423)
	Taper	Production	.0003 (0.00508) Maximum
		Service	.001 (0.02) Maximum
	Out-of-Round	Production	.0002 (0.007) Maximum
		Service	.001 (0.02) Maximum
Rod Bearing Clearance		Production	.0013-.0035 (0.0330-0.0889)
		Service	.001-.003 (0.02-0.07) Maximum
Rod Side Clearance			.006-.017 (0.152-0.44)

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

VALVE SYSTEM

Lifter			Hydraulic Roller
Rocker Arm Ratio			1.50:1
Valve Lift		Intake	.414 (10.52)
		Exhaust	.428 (10.87)
Valve Lash (Intake and Exhaust)			Net Lash No Adjustment
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			.002 (0.05) Maximum
Seat Width		Intake	.035-.060 (0.89-1.52)
		Exhaust	.062-.093 (1.58-2.38)
Stem Clearance	Production	Intake	.0011-.0027 (0.0279-0.069)
		Exhaust	
	Service	Intake	.001 (0.025) Maximum
		Exhaust	.002 (0.51) Maximum
Stem Diameter		Intake	.341 (8.64)
		Exhaust	
Valve Margin Intake and Exhaust			.031 (0.79)

VALVE SPRING

Valve Spring	Free Length		2.03 (51.6)
	Pressure	Valve Closed	76-84 Lb. (338-374 N) at 1.7 in (43.16 mm)
		Valve Open	187-203 Lb. (832-903 N) at 1.27 in (32.25 mm)
	Installed Height Intake		1.78 in (45.2 mm)
	Installed Height Exhaust		1.69-1.71 in. (42.9-43.43)

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

CAMSHAFT AND DRIVE

Lobe Lift ±. 002(0.051)	Intake	.286-.290 (7.26-7.36)
	Exhaust	.292-.296 (7.42-7.52)
Journal Diameter		1.8682-1.8692 (47.452-47.478)
Journal Out of Round		.001 (0.025) Maximum
Camshaft Runout		.002 (0.051) Maximum
Camshaft End Play		.001-.009 (0..0254-0.2286)
Timing Chain Deflection		.375 (9.5) from taut position [total .75 (19)]

FLYWHEEL

Runout	.008 (0.203) Maximum

CYLINDER HEAD

Gasket Surface Flatness	.010 (0.254) Overall Maximum

BALANCE SHAFT

Front Bearing Journal		2.1648-2.1654 (55.985-55.001)
Rear Bearing Journal		1.4994-1.500 (38.084-38.100)
Rear Bearing Inside Diameter Assembled	Production	1.5014-1.503 (37.525-37.575)
Rear Bearing Outside Diameter	Production	1.875-1.876 (46.875-46.900)
Rear Cylinder Block Housing Bore	Production	1.873-1.874 (46.825-46.850)
Rear Bearing Journal Clearance		.001-.0036 (.025-.091)

General

Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

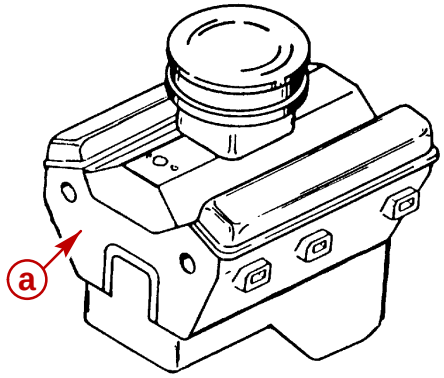
When engine removal is not required, make certain that battery cables are disconnected at the battery prior to performing any on-board engine repair procedure.

Lubricate all moving parts (during reassembly) with engine oil. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.

Engine Identification

The Mercury MerCruiser Model can be determined by looking at the last two letters of the engine code stamped into the cylinder block. This code number is stamped on all Mercury MerCruiser power packages and replacement partial engines, but not replacement cylinder block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.



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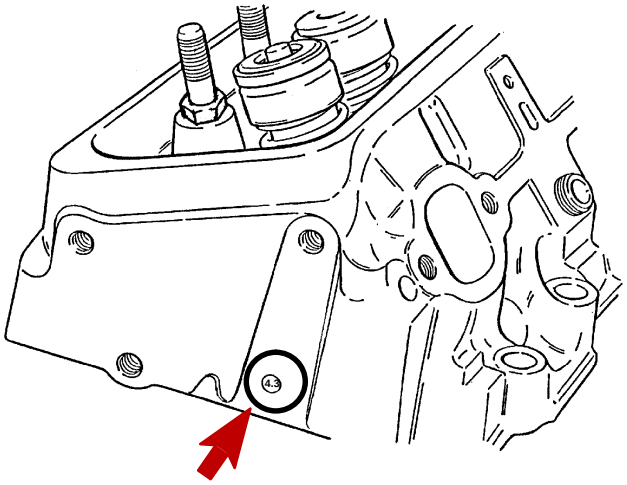
a - Location of GM Engine Code (Front Starboard Side, Near Cylinder Head Mating Surface)

MCM (Sterndrive)	Code	Rotation
4.3L	LJ	LH
4.3LH	LK	
4.3L EFI	LK	

Cylinder Head Identification



72875

a - Left Hand Rotation (CCW) - All Sterndrive Engines

Crankshaft

The crankshaft is supported in the block by four insert type bearings. Crankshaft end thrust is controlled by flanges on the No. 4 bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft through insert type bearings.

Camshaft and Drive

Camshafts are generally cast iron. However, engines with roller lifters have steel camshafts. All camshafts are driven at 1/2 crankshaft speed by a timing chain and sprockets, and are supported by four main bearings, which are pressed into the block.

A helical gear on the aft end of the camshaft drives the distributor and oil pump.

Balance Shaft

The balance shaft is located in the engine block valley directly above and parallel to the camshaft. The balance shaft extends the entire length of the engine and is supported on each end by a bearing. It is also driven by the camshaft through a helical gear set. The function of the balance shaft is to equalize the dynamic forces inherent in particular engine designs, thus minimizing engine vibration.

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or graphite composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are of a heavy-duty design to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used to help extend valve life.

Hydraulic valve roller lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which in turn actuate the valves through the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serve to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The roller lifters are restrained from rotating by two retainers (restrictors) located in the valley. The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The manifold is of the single level design for efficient fuel distribution. All passages are of approximately equal length to assure more even fuel-air mixture to the cylinders.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If the screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into the system. Once the oil reaches the pump, the pump forces the oil through the lubrication system. A spring-loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows through a full-flow oil filter. On engines with an engine oil cooler, the oil also flows through the cooler before returning to the block. A bypass valve allows oil to bypass the filter and oil cooler should they become restricted.

Some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 4 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed through individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2 and 3 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

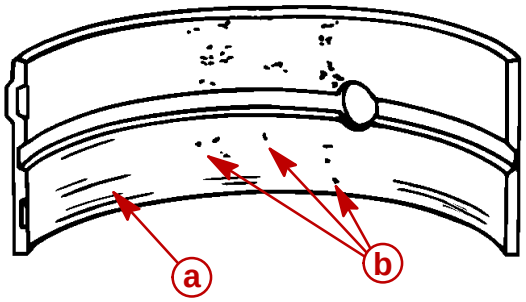
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow in-between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto the camshaft drive and keeps it lubricated.

The oil which reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil which is forced out the front end of the No. 1 crankshaft main bearing also assists in lubricating the camshaft drive.

Oil which reaches the valve lifter oil galleries is forced into each hydraulic valve lifter through holes in the side of the lifter. From here, the oil is forced through the metering valve in each of the lifters (which controls the volume of oil flow) and then up through the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass through the rocker arm and lubricate the valve train bearing surfaces. After lubricating the valve train, oil drains back to the oil pan through oil return holes in the cylinder head and block.

The distributor shaft and gear also is lubricated by the oil flowing through the right valve lifter oil gallery.

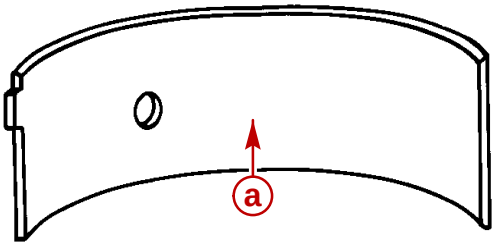
Bearing Failures



70436

Scratched By Dirt

a - Scratches
b - Dirt Imbedded In Bearing Material

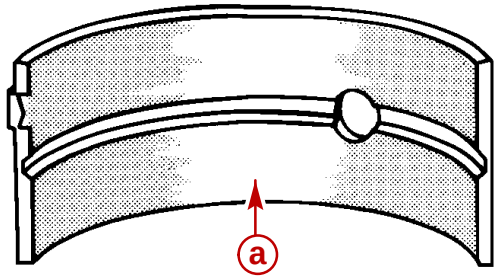


70436

Tapered Journal

a - Overlay Gone From Entire Surface

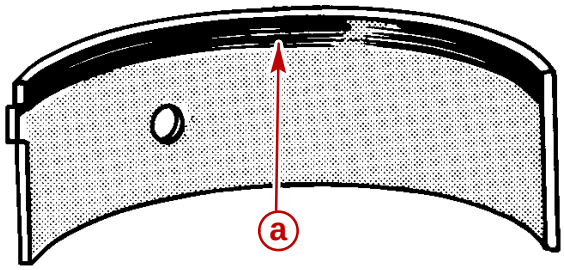
Bearing Failures (Continued)



70436

Lack Of Oil

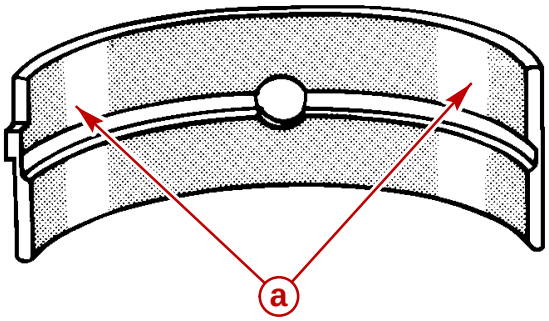
a - Overlay Worn Off



70436

Radius Ride

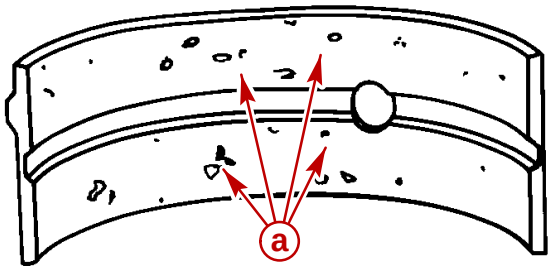
a - Worn Area



70436

Improper Seating

a - Bright Or Polished Sections



70436

Fatigue Failure

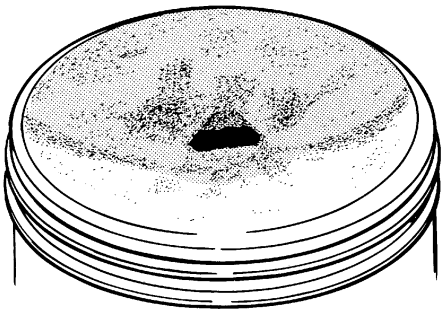
a - Craters or Pockets

Piston Failures

NOTE: *Engine failure due to pre ignition or detonation are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

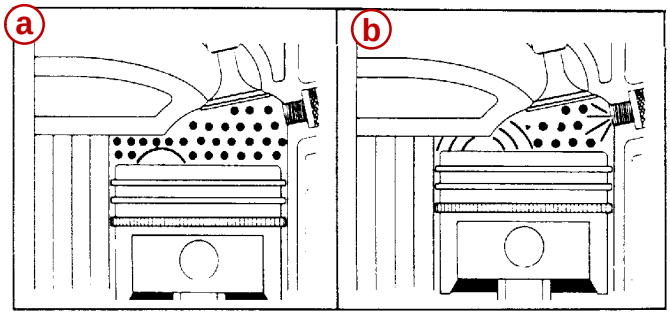
Pre-Ignition

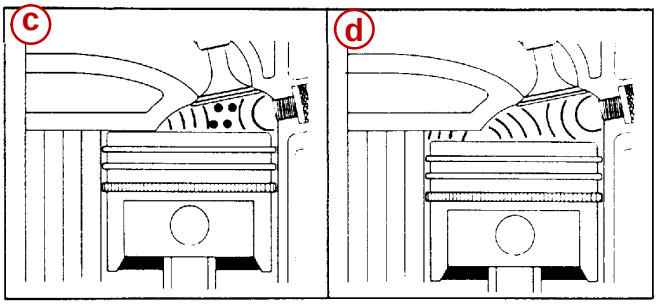
Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



72424

Pre-Ignition Damage





72314

Combustion Differences

- **a -** Ignited By Hot Deposits
- **b -** Regular Ignition Spark
- **c -** Ignites Remaining Fuel
- **d -** Flame Front Collide

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Detonation

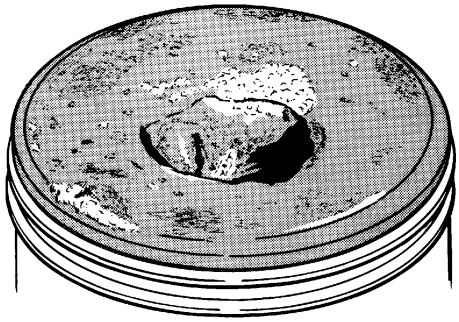
Detonation, commonly called “fuel knock,” “spark knock” or “carbon knock,” is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

OTHER CAUSES OF DETONATION

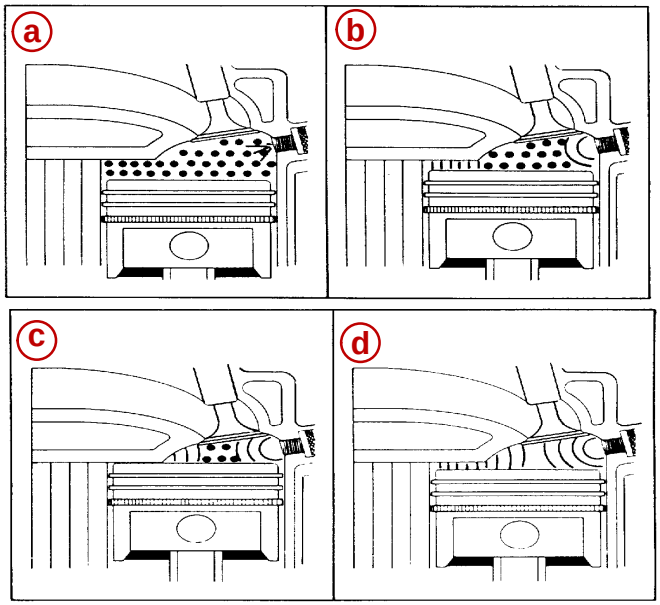
IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.



72425

Detonation Damage

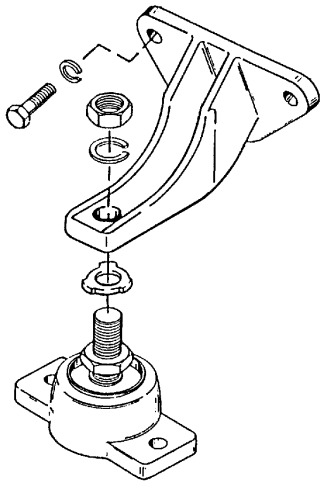


72315

Combustion Description

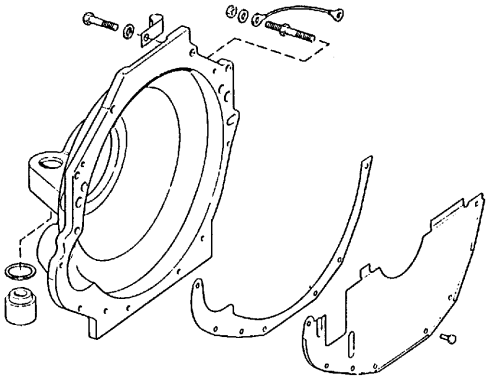
a - Spark Occurs
b - Combustion Begins
c - Combustion Continues
d - Detonation Occurs

Engine Mounts



72316

Front Mount



72318

Rear Mount/Flywheel Housing

IMPORTANT: Press rear mount out with press.

Rocker Arm Cover

Removal

It may be necessary to remove exhaust manifold before removing rocker arm cover. (Refer to Section 7B)

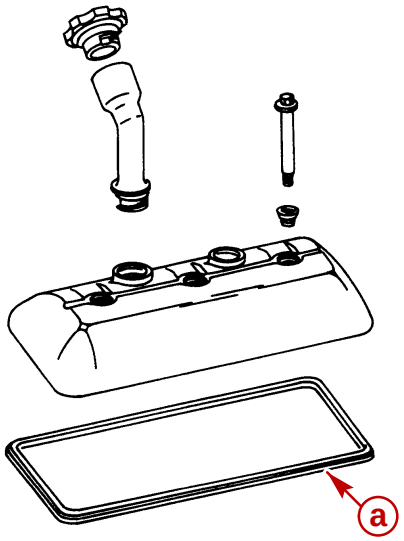
1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of rocker arm covers.

IMPORTANT: DO NOT pry rocker arm cover loose. Gaskets, which may adhere to cylinder head and rocker arm cover, may be loosened by bumping end of rocker cover from the rear with palm of hand or a rubber mallet.

3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket in position in rocker arm cover.



75853

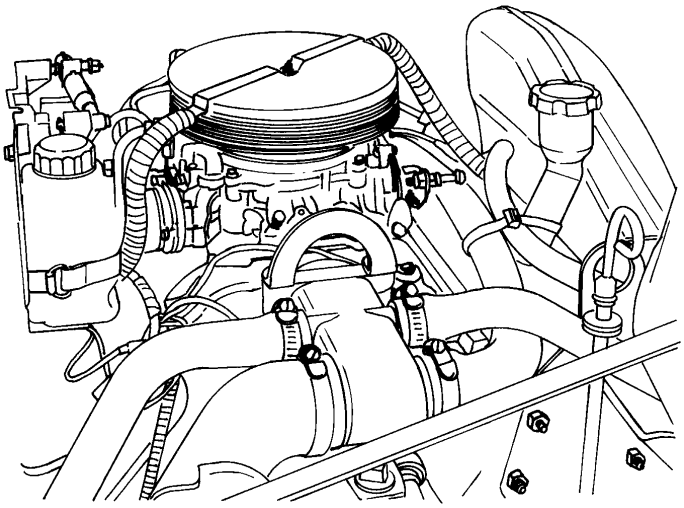
a - Rocker Arm Cover Gasket

3. Install rocker arm cover. Torque screws to 106 lb-in. (12 Nm).
4. Install exhaust manifolds, if removed.
5. Install any items which were removed to allow removal of rocker arm covers.
6. Connect crankcase ventilation hoses to rocker arm covers.
7. Start engine and check for oil leaks.

Intake Manifold

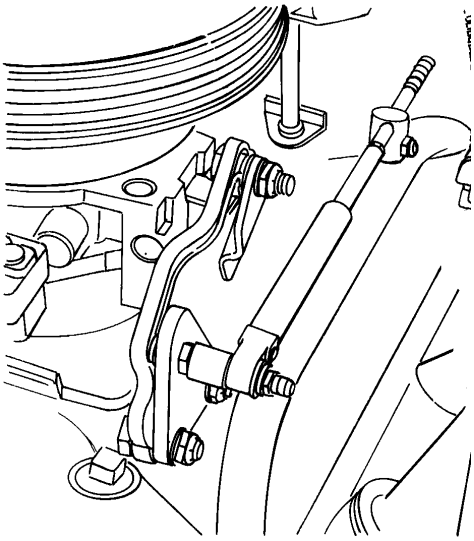
Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.



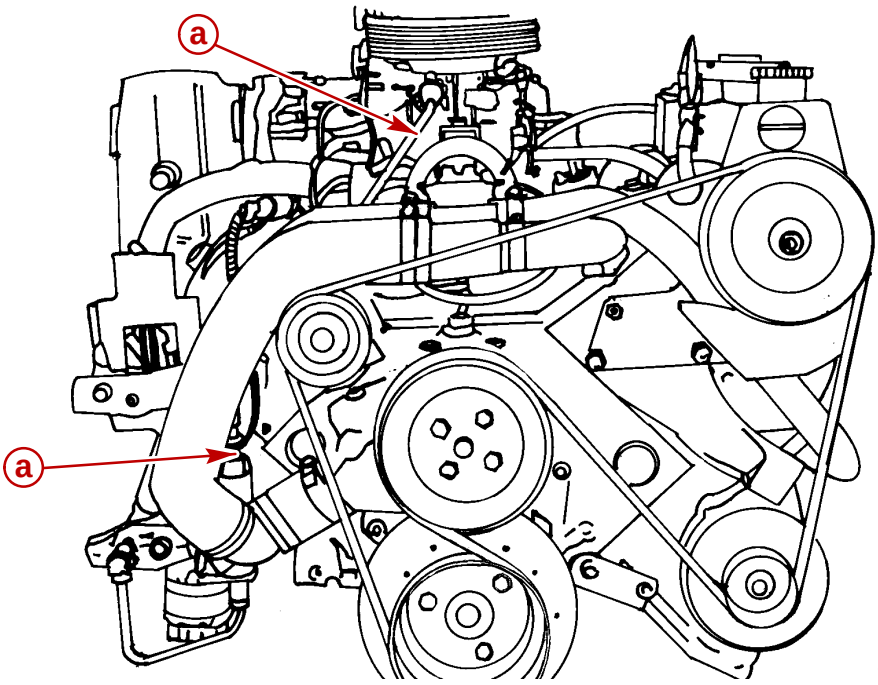
75847

3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable from carburetor or throttle body.



75867

6. Remove fuel line running between fuel pump and carburetor or throttle body.



76404

a - Fuel Line

7. Remove distributor cap and mark position of rotor on distributor housing. Also, mark position of distributor housing on intake manifold.
8. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

9. Remove other ignition components.
10. Remove oil sending unit.
11. Disconnect any other miscellaneous items that will prevent removal of manifold.

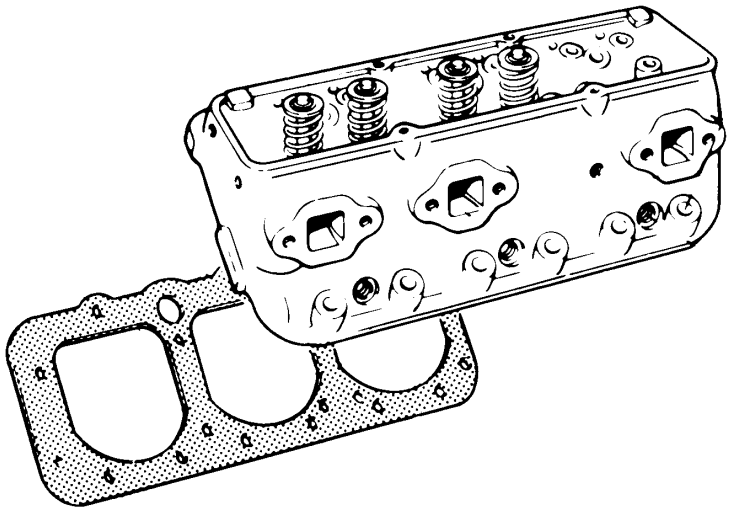
IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

12. Remove intake manifold bolts, then remove intake manifold and carburetor assembly.

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.



75853

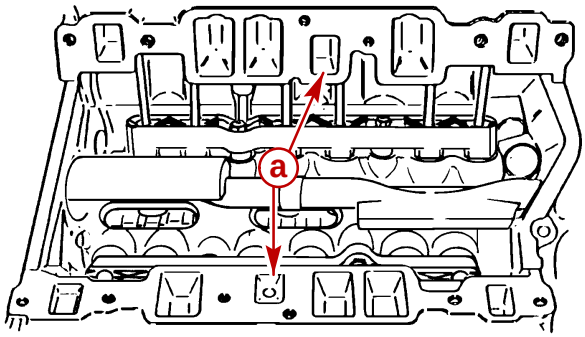
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or cylinder head ports.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Check intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets, in next step, observe the following:

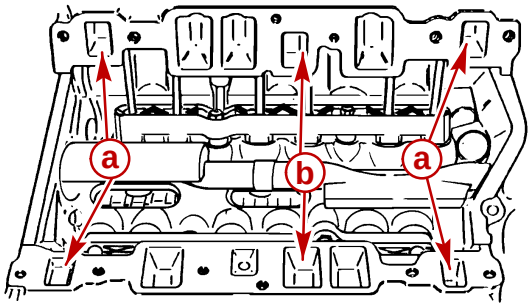
- **Be sure to install gasket with marked side up. Both gaskets are identical.**
- **On engines with 2 barrel carburetor, remove metal insert from manifold gasket to be used on starboard (right) cylinder head to provide clearance for heat pipe on intake manifold.**
- **All Mercury MerCruiser V-6 GM engines that have “automatic” carburetor chokes must use an intake gasket that has an opening for the exhaust crossover port in the intake manifold. Without this opening the “automatic” carburetor choke will not operate properly. The choke will remain ON longer causing rough engine operation and wasted fuel.**



71850

a - Exhaust Crossover Port Opening

1. Apply Quicksilver Perfect Seal to intake manifold gaskets especially around coolant passages (both sides).
2. Place gaskets on cylinder heads.

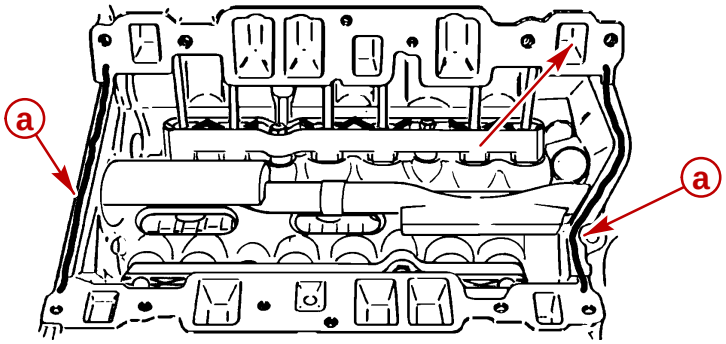


71850

a - Coolant Passages
b - Gaskets

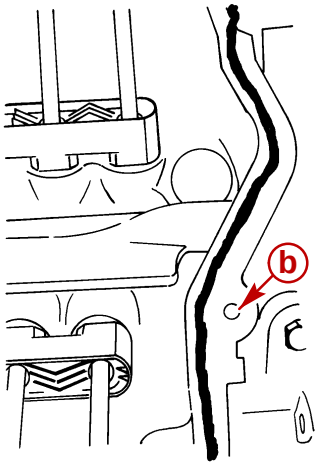
3. Apply a 3/16 in. (5 mm) wide bead of Quicksilver RTV Sealer to engine block as shown. Extend sealer 1/2 in. (13 mm) up on intake gaskets.

IMPORTANT: DO NOT get Quicksilver RTV Sealer into oil sending unit hole at rear of engine.



71850

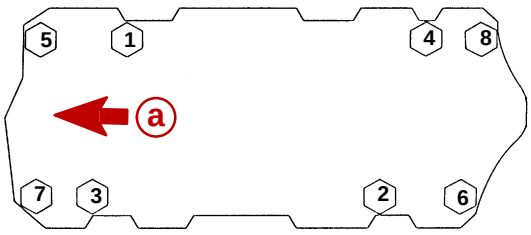
a - RTV Sealer (Typical Both Ends)



71851

b - Oil Sending Unit Hole

4. Carefully install manifold assembly and torque bolts to 35 lb-ft (48 Nm) in sequence as shown.



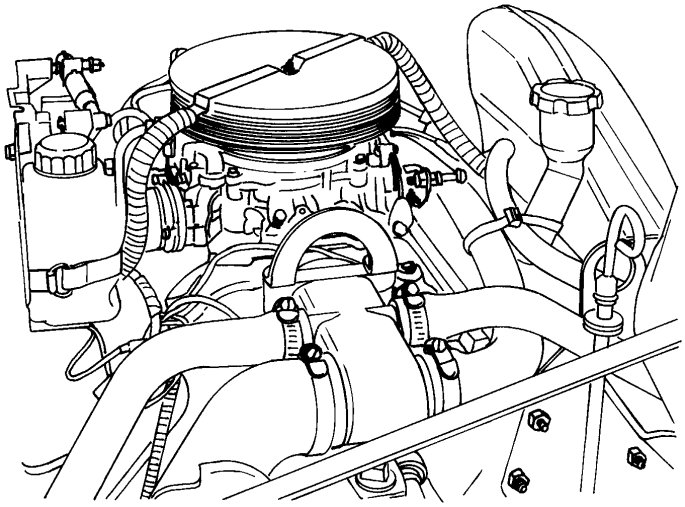
72878

Intake Manifold Torque Sequence

a - Front

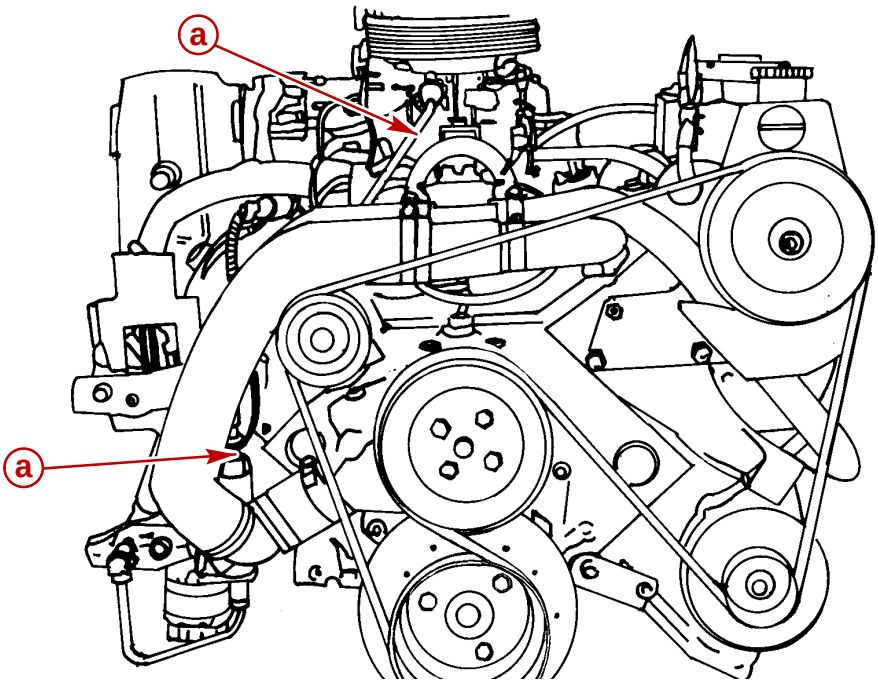
5. Connect all electrical leads.

6. Connect hoses to thermostat housing.



75847

7. Install fuel line to carburetor and fuel pump.



76404

a - Fuel Line

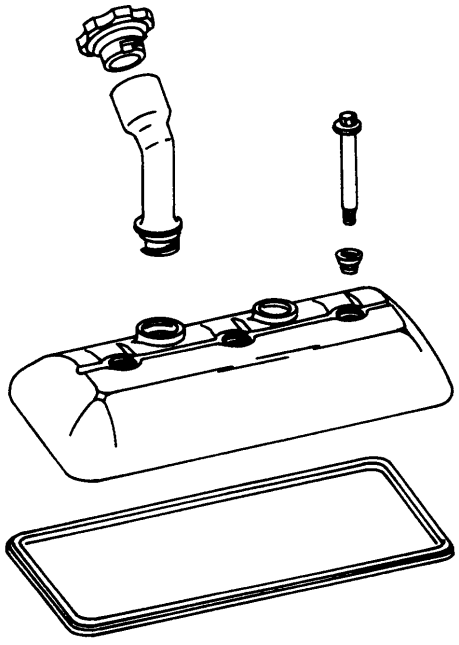
8. Connect crankcase ventilation hoses to rocker arm covers.
9. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
10. Install other ignition components and reconnect wires.
11. Coat threads of oil pressure sending unit with Quicksilver Perfect Seal and install.
12. Connect any other items which were disconnected from manifold during removal.
13. Start engine.
14. Adjust ignition timing and carburetor.
15. Check hose connections, gaskets and seals for leaks.
16. Inspect fuel line connections for fuel leaks.

Rocker Arm/Push Rod

Removal

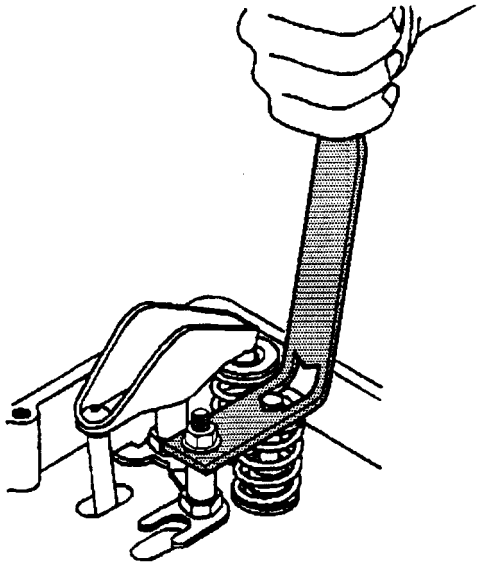
NOTE: *When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.*

1. Remove rocker arm covers.



75853

2. Remove rocker arm assemblies and push rods.



75674

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

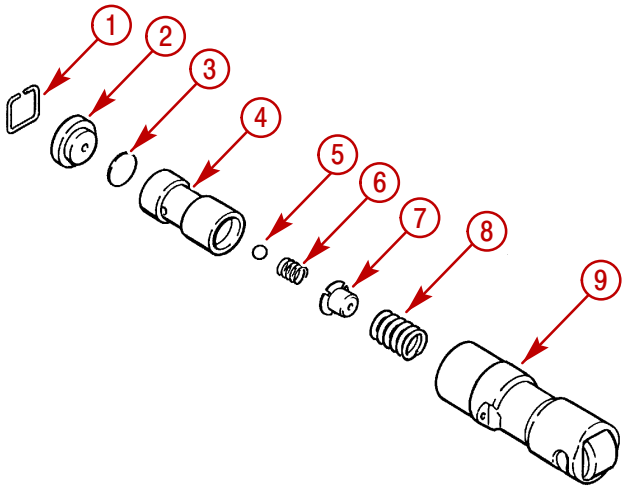
Installation

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

1. Install push rods in their original locations. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts in their original locations.
3. Torque rocker arm nuts to 22 lb-ft (30 Nm). No valve adjustment is required. Valve lash is automatically set when rocker arm nuts are torqued to specification.

Hydraulic Roller Valve Lifters

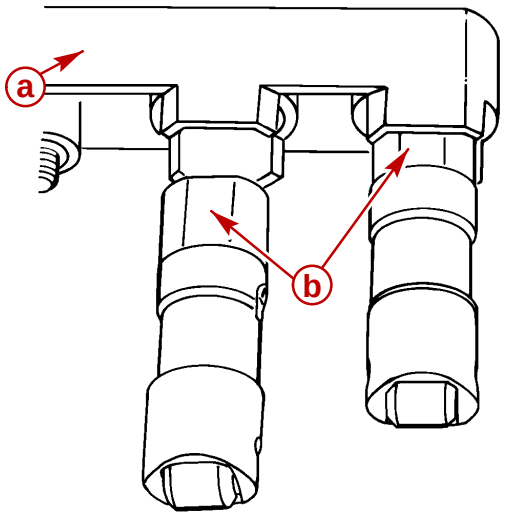
Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.



72031

1 - Push Rod Seat Retainer
2 - Push Rod Seat
3 - Metering Valve
4 - Plunger
5 - Check Ball
6 - Check Ball Spring
7 - Check Ball Retainer
8 - Plunger Spring
9 - Lifter Body

Valve lifters are retained in position and prevented from rotating by two valve retainers, one on each side of the engine beneath the intake manifold. Care should be exercised when installing the retainers to see that the flat portions of the lifters are properly positioned into the retainers.



71853

a - Retainer
b - Roller Lifter Flat Portion

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

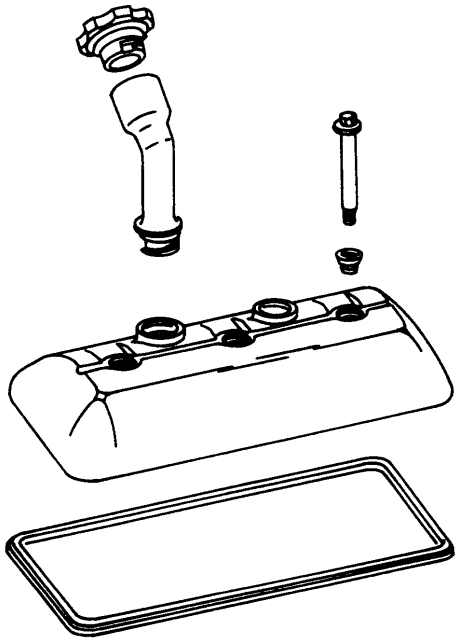
General types of valve lifter noise are as follows:

1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or “pickup” between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise - probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train - this will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking - probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out of round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it more likely exists in all the units; thus it would only be a matter of time before all lifters caused trouble.

Removal

1. Remove rocker arm covers.

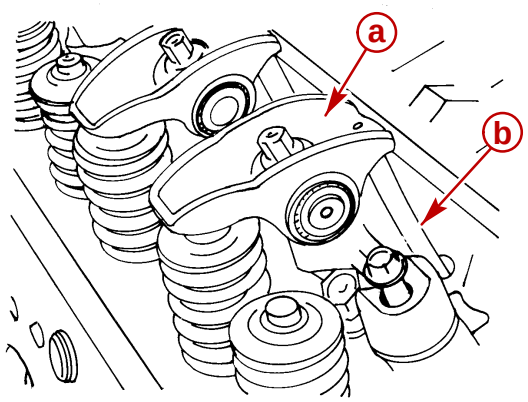


75853

2. Remove intake manifold.

IMPORTANT: Keep valve push rod and hydraulic lifter from each valve together as a matched set and mark or store them so they can be reinstalled in the same location later.

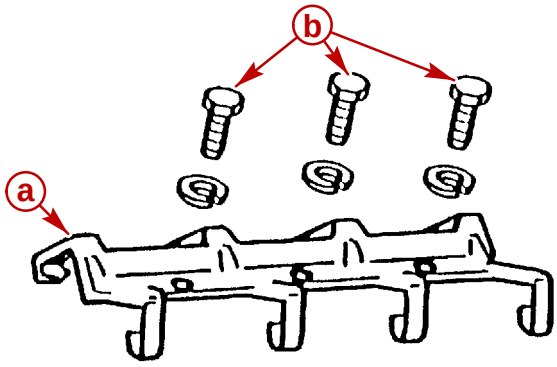
3. Remove rocker arm assemblies and push rods.



75670

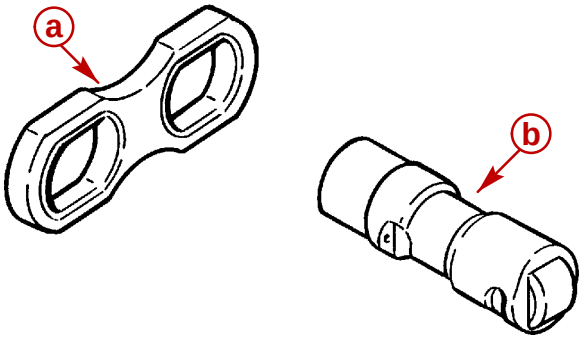
a - Rocker Arm Assembly
b - Push Rods

NOTE: *Engines with roller lifters have additional valve train components shown below.*



72329

a - Lifter Restrictor Retainer
b - Fasteners

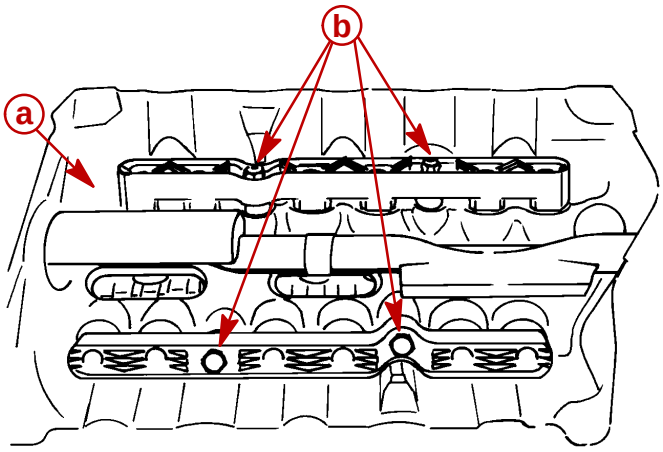


72340

a - Roller Lifter Restrictor
b - Roller Lifter

4. Remove lifter restrictors and lifters.

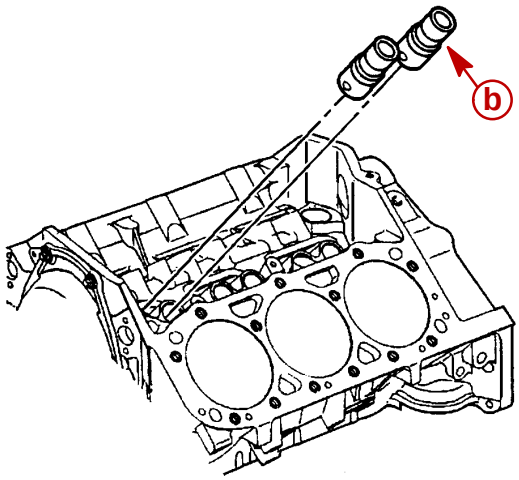
5. Remove fasteners from lifter retainers (restrictors) and remove retainers. Do not disturb lifters at this time.



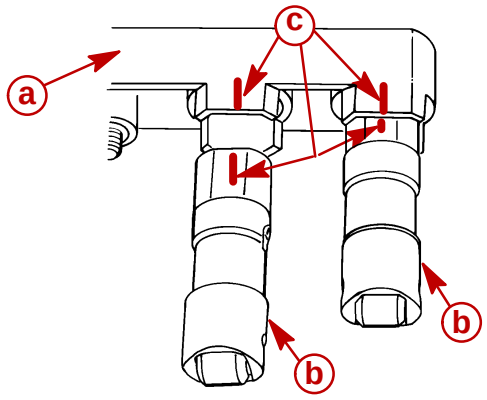
71852

a - Lifter Retainer (Restrictor)
b - Fasteners

6. Make matching marks on all retainers and lifters as to location and orientation in bores, to allow reassembly in exact position on camshaft lobes (so that the roller's bearing and roller will roll in the same direction on the same lobe, if reused).
7. Remove valve lifters.



76586



71853

a - Roller Lifter Retainer
b - Roller Lifter(s)
c - Matching Marks

Index

Cleaning and Inspection

1. Thoroughly clean all parts in cleaning solvent and inspect them carefully.
2. If any parts are damaged or worn, entire lifter assembly should be replaced.
3. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore.
4. If roller is worn or damaged, inspect camshaft lobe.
5. If push rod seat is scuffed or worn, inspect push rod.

Installation

IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

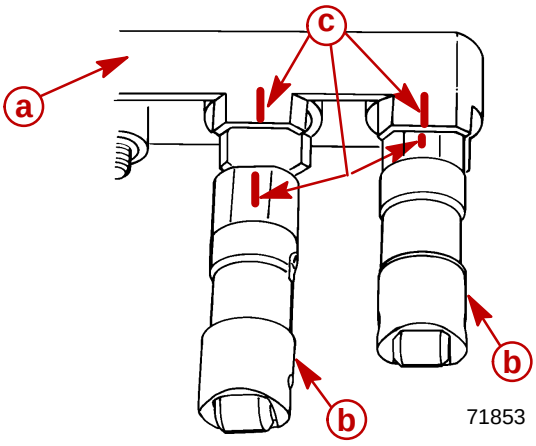
IMPORTANT: Before installing roller lifters, coat the roller with engine oil. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Prelube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: Before installation, coat entire valve lifter with engine oil.

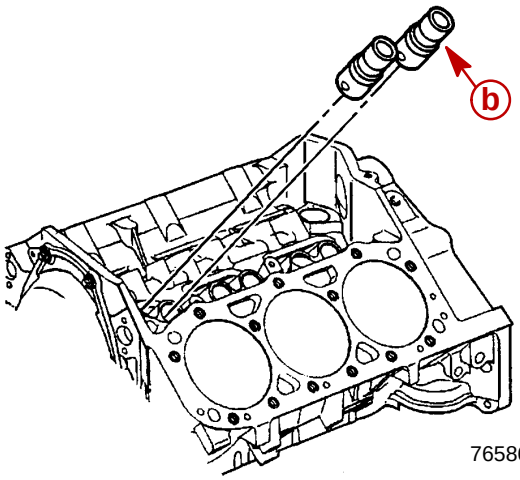
IMPORTANT: DO NOT install used valve lifters if a new camshaft has been installed.

1. Align matching marks made prior to disassembly, and install hydraulic valve lifters and components. Torque roller lifter retainer (restrictor) plate fasteners to 12 lb-ft (16 Nm).

NOTE: *Components shown removed in left drawing for visual clarity*

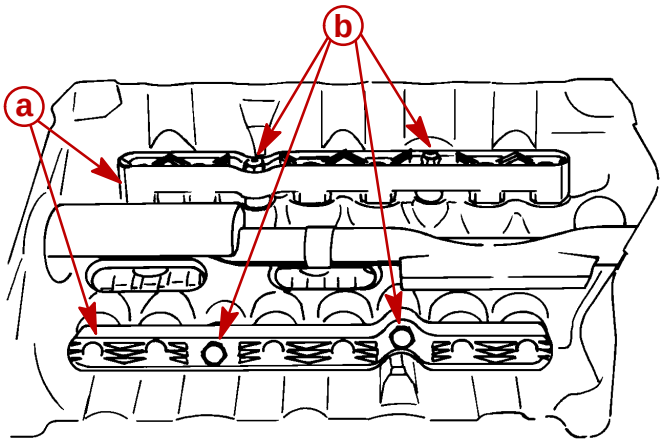


71853



76586

a - Roller Lifter Retainer
b - Roller Lifter(s)
c - Matching Marks



71852

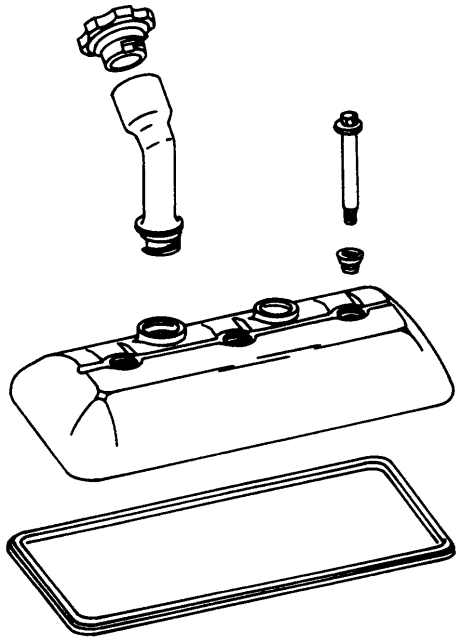
a - Lifter Retainer (Restrictor)
b - Fasteners

2. Install intake manifold.
3. Install push rods. Ensure push rods seat in lifter socket.
4. Install rocker arms and rocker arm nuts. Torque nuts to 22 lb-ft (30 Nm).
5. Install rocker arm cover. Torque fasteners to 106 lb-in. (12 Nm).
6. Start engine and check for leaks.

Valve Stem Oil Seal / Valve Spring Replacement

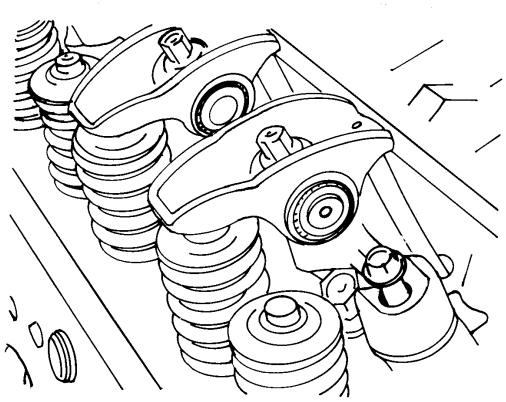
Removal - Head Installed

1. Remove rocker arm cover.



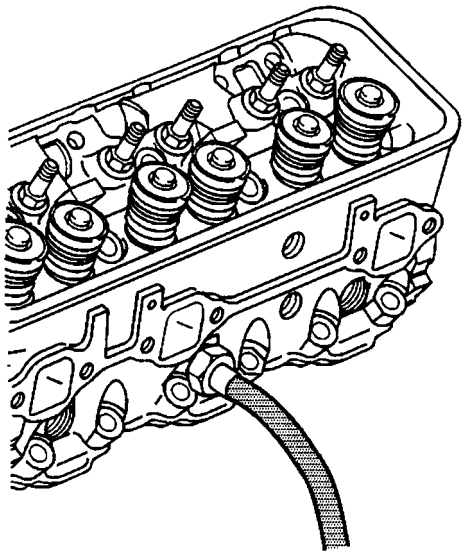
75853

2. Remove spark plug of affected cylinder.
3. Remove rocker arm assembly.



75670

4. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

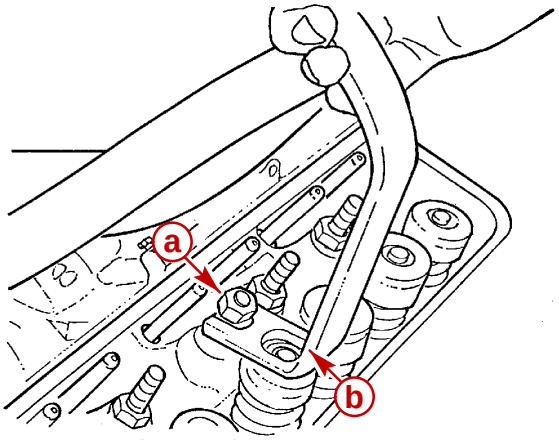


76572

NOTE: *If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.*

IMPORTANT: Do not turn crankshaft while valve springs, retainers and locks are removed or valves will fall into cylinder.

5. Using valve spring compressor as shown, compress valve spring and remove valve locks.



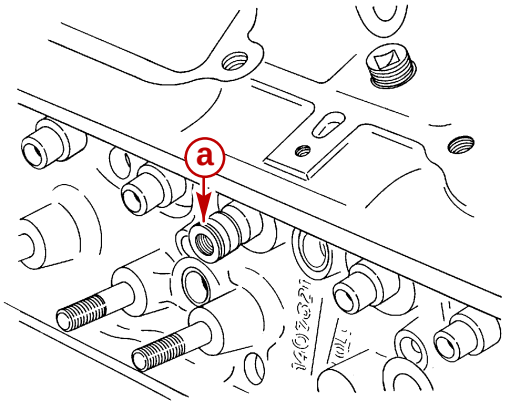
72881

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

6. Slowly release valve spring compressor. Remove cap, retainer or rotator, and valve spring.

IMPORTANT: Keep air pressure in cylinder while springs, caps and valve locks are removed or valves will fall into cylinder.

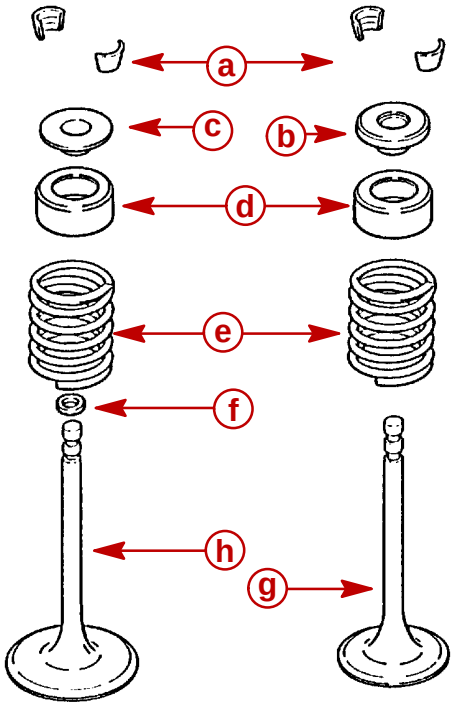
7. Remove seals from valve stems and valve guide.



72330

a - Intake Valve Guide Seal

Valve Assembly (Exploded View)



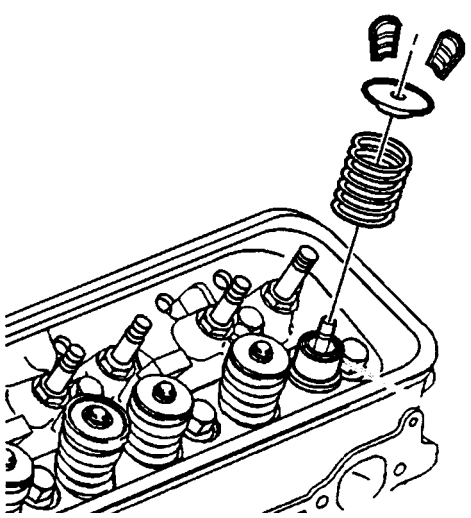
75843

a - Valve Locks
b - Retainer
c - Rotator
d - Cap
e - Outer Spring
f - Valve Stem Oil Seal
g - Intake Valve
h - Exhaust Valve

1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.

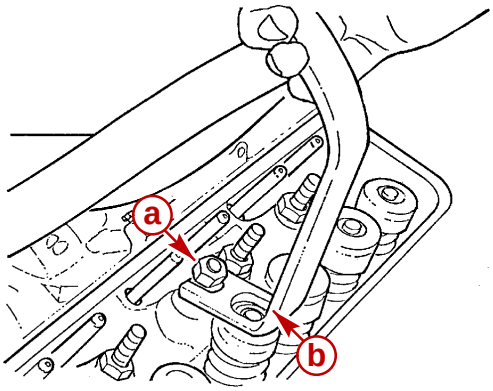
Installation - Head Installed

1. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
2. Set valve spring (with damper installed) and cap in place.
3. Place retainer on intake valve and/or rotator on exhaust valve.



76573

4. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.
5. Install valve locks (Quicksilver Needle Bearing Assembly Lubricant may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.

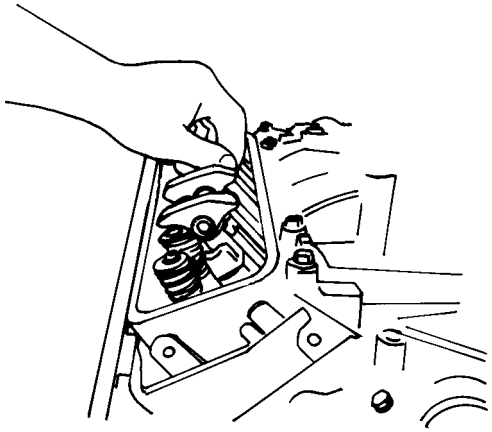


72881

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

6. Install push rods and rocker arm assemblies.

7. Torque rocker arm nuts to 22 lb-ft (30 Nm).



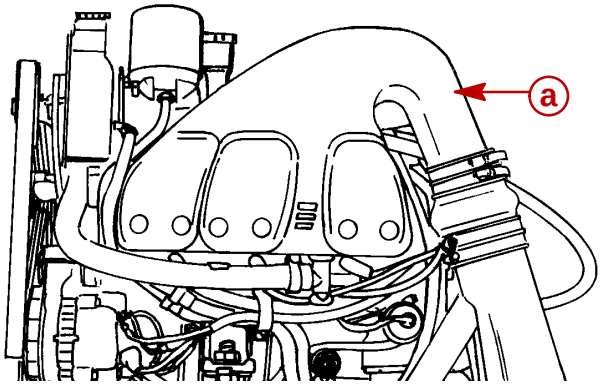
76569

8. Install rocker arm cover. Torque to 106 lb-in. (12 Nm).
9. Install spark plug torque to 15 lb-ft (20 Nm).

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove exhaust manifolds.



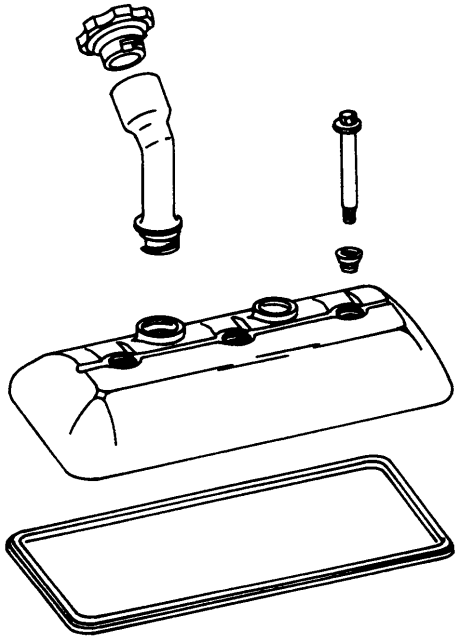
75052

One Piece Exhaust Manifold Shown

a - Exhaust Manifold

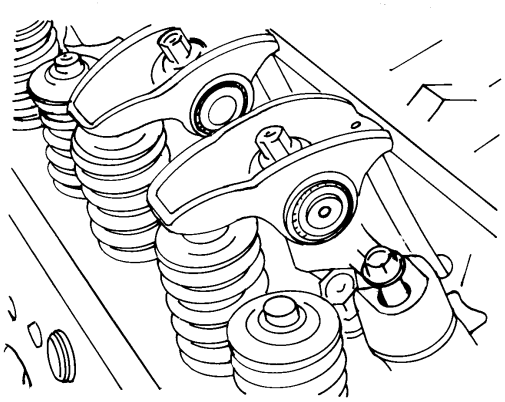
3. Remove intake manifold.

4. Remove rocker arm covers.



75853

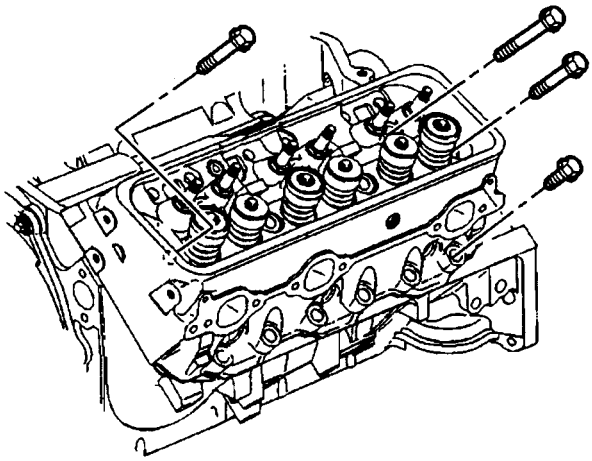
5. Remove rocker arm assemblies and push rods (keep in order for reassembly in their original locations).



75670

6. Remove any components attached to front or rear of cylinder head.
7. Remove spark plugs.

8. Remove head bolts.

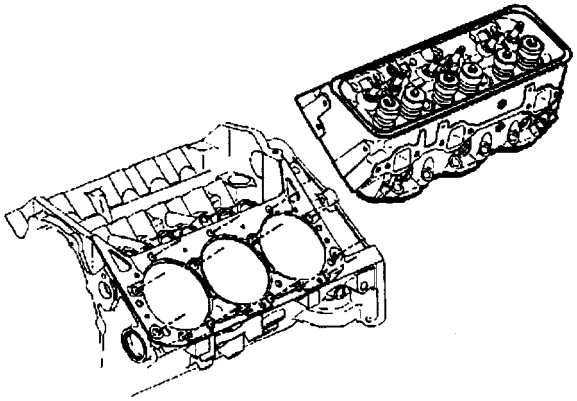


76589

⚠ CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

9. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.



76576

Cleaning and Inspection

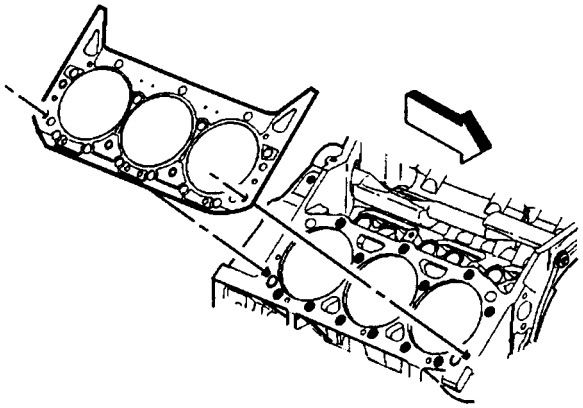
1. Clean gasket material and sealer from engine block and cylinder heads.
2. Inspect sealing surfaces for deep nicks and scratches.
3. Inspect for corrosion around cooling passages.
4. Clean head bolt threads and engine block bolt hole threads, making sure no dirt, old oil or coolant remain.

Installation

⚠ CAUTION

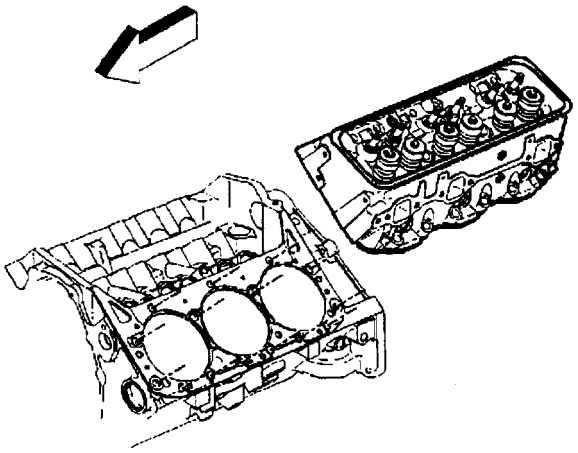
When using ribbed stainless steel head gaskets, apply a thin coating of Quicksilver Perfect Seal to both sides of gasket. Too much sealer may hold gasket away from head or block causing leakage. DO NOT use sealer on graphite composition head gaskets.

1. Place head gasket in position over dowel pins.



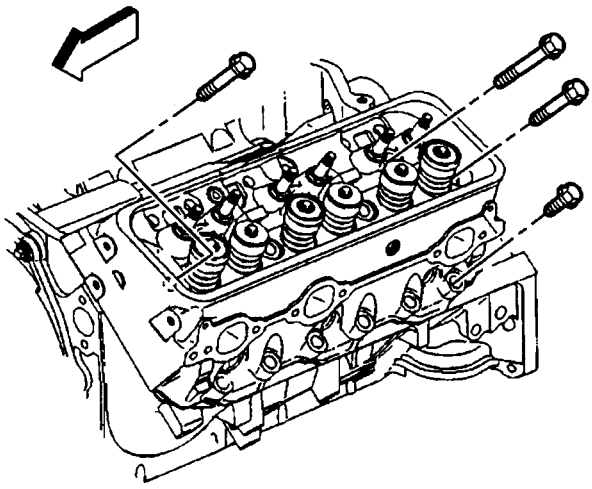
76588

2. Carefully set cylinder head in place over dowel pins.



76576

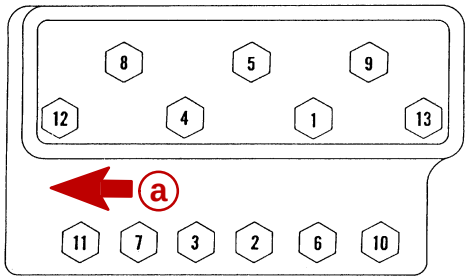
3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.



76589

4. Torque cylinder heads in two steps. First pass, torque all bolts to 22 lb-ft (30 Nm). Second pass is an angle torque sequence as follows:

First Pass	Short Bolt Medium Bolt Long Bolt	22 lb-ft (30 Nm)
Second Pass (Angle Torque)	Short Bolt	+ 55 Degrees
	Medium Bolt	+ 65 Degrees
	Long Bolt	+ 75 Degrees

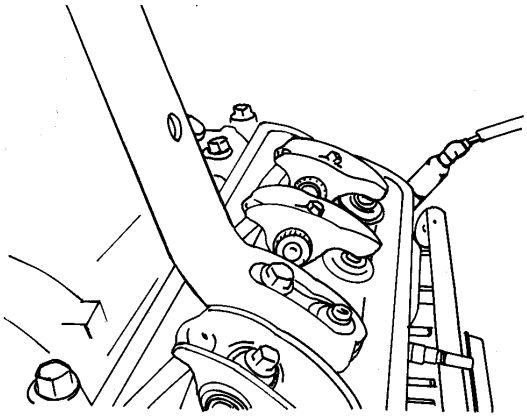


72883

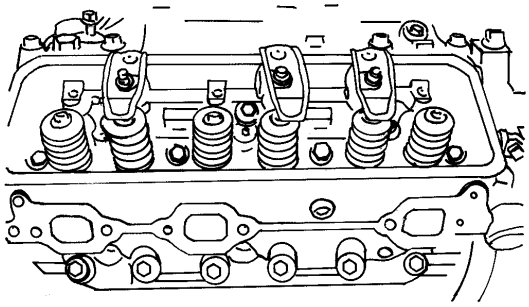
Cylinder Head Torque Sequence

a - Front

5. Install push rods, rocker arm assemblies and lifter restrictors in their original positions.

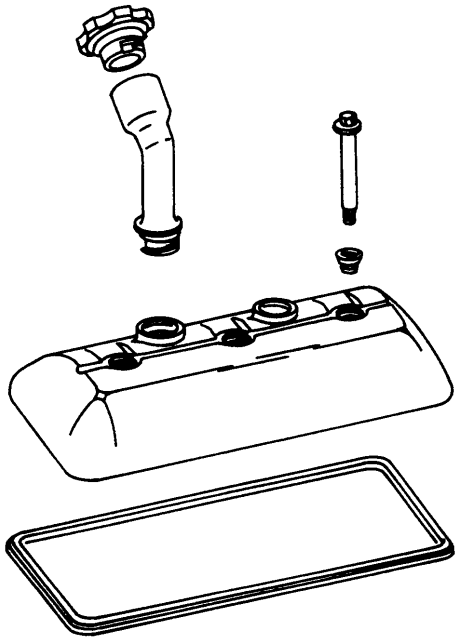


76567



76568

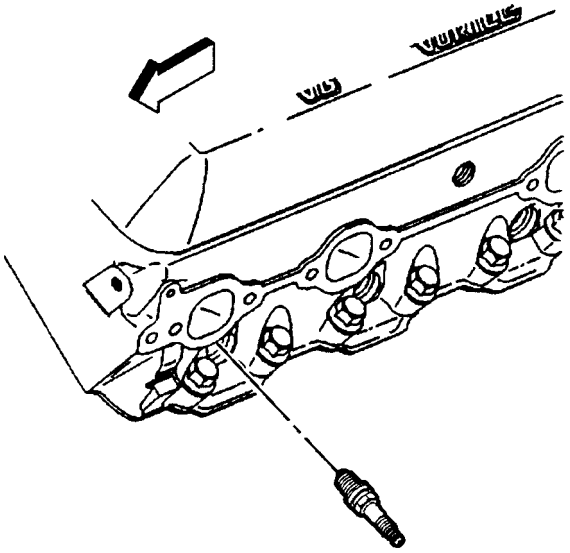
6. Torque rocker arm nuts to 22 lb-ft (30 Nm).
7. Install intake manifold.
8. Install rocker arm covers.



75853

9. Install exhaust manifolds.

10. Install spark plugs.



76587

11. Install any components removed from front or rear of cylinder heads.

12. Follow procedures below for your model. Refer to SECTION 6A or 6B of this manual.

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see Section 6A).

Closed Cooled Models: Refill closed cooling section (see Section 6B), and provide adequate water supply to seawater pickup.

⚠ CAUTION

Ensure that cooling water supply is available before starting the engine.

13. Start engine.

14. Set timing.

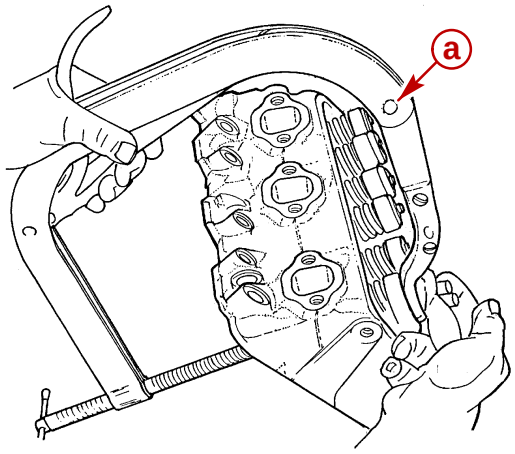
15. Set idle speed.

16. Check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.



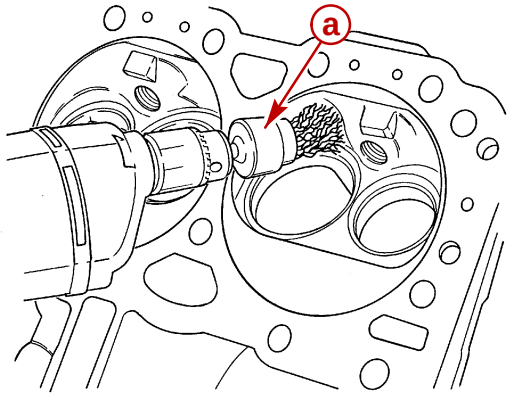
72884

a - Valve Spring Compressor (J-8062)

2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, in order, for reassembly in their original locations.

Cleaning

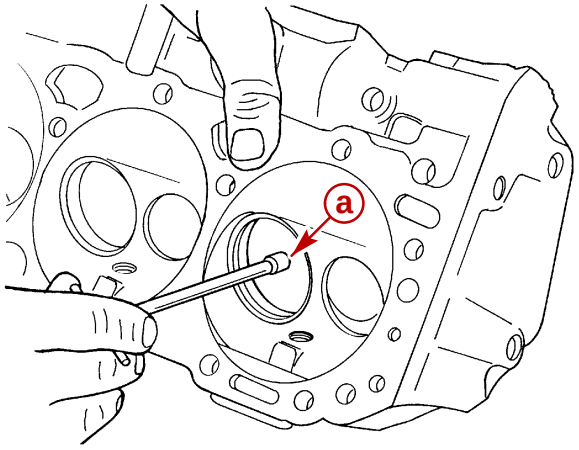
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using a wire wheel.
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



72334

a - Carbon Remover Brush (J-8089)

5. Thoroughly clean valve guides with valve guide cleaner.

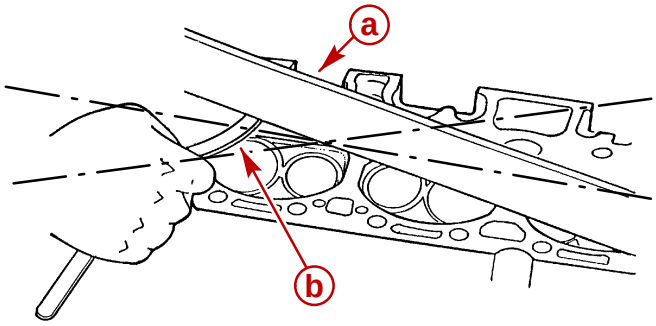


72335

a - Valve Guide Cleaner (J-8101)

Inspection

1. Inspect cylinder heads for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace heads if any cracks are found.
2. Inspect cylinder head gasket surface for burrs, nicks, erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Take measurements diagonally across head (both ways) and straight down center head. Refer to "Specifications."



72885

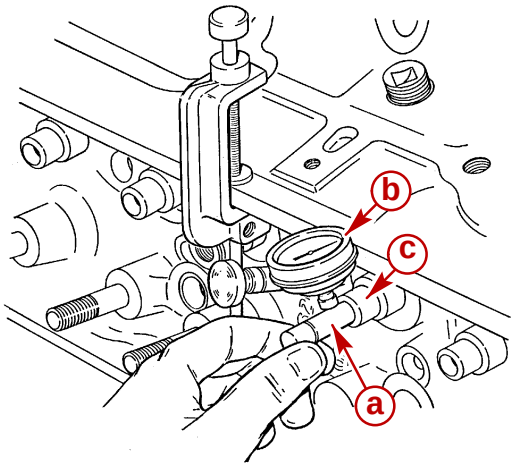
a - Straight Edge
b - Feeler Gauge

IMPORTANT: Cylinder head-to-block gasket surface should be resurfaced if warped more than specified. When head resurfacing is required, cylinder head-to-intake manifold gasket surface on head must be milled to provide proper alignment between intake manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

4. Measure valve stem clearance as follows:
   a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.
   b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.
   c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves, as outlined under “Valve Guide Bore Repair.”



72336

a - Valve Stem
b - Dial Indicator
c - Valve Guide

Valve Guide Bore Repair

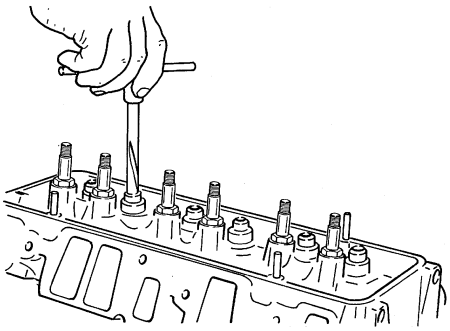
IMPORTANT: Be sure to measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015 in. oversize valves are required, ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size valve guide reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for .015 in. Oversize Valve
.341 in.	J-5830-2

2. Ream valve guide bores, as shown.



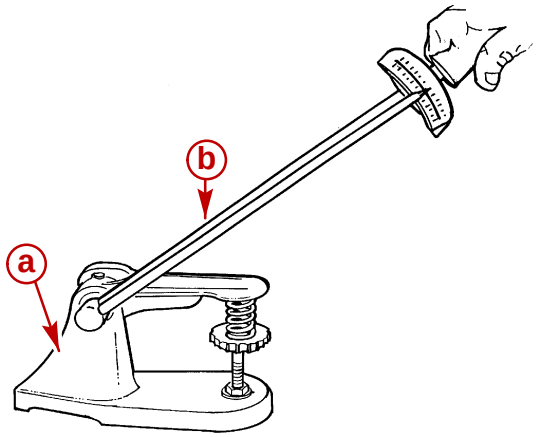
72886

3. Remove the sharp corner created by reamer at top of valve guide.

Valve Springs - Checking Tension

Using valve spring tester, as shown, check valve spring tension with dampers removed. Refer to “Specifications.”

IMPORTANT: Springs should be replaced if not within 10 lbs. (44 N) of specified tension.



72308

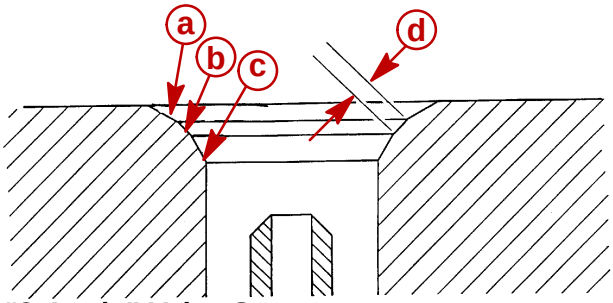
a - Valve Spring Tester (J-8056)
b - Torque Wrench

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to ensure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer’s recommendations should be followed carefully to attain proper results.

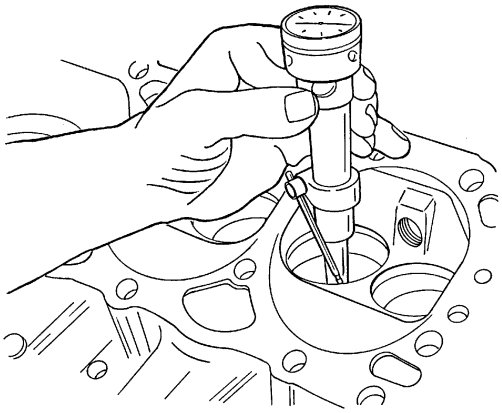


50668

Typical “3-Angle” Valve Seat

a - Top Angle (30°)
b - Seat Angle (46°)
c - Bottom Angle (60°)
d - Seat Width

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.



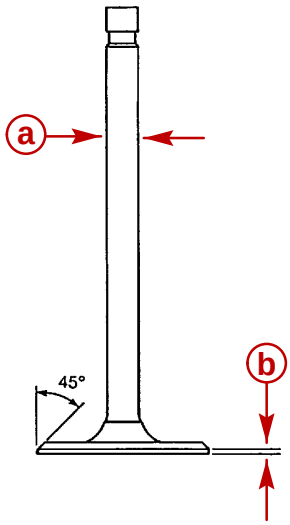
72338

Measuring Valve Seat Concentricity

Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems which show excessive wear, or valves that are warped excessively, must be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head, due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning, or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1/32 in. (0.8 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.



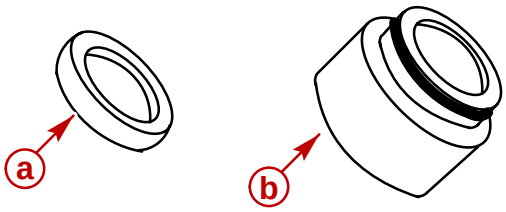
50695

a - 1/3 [.341 in] (8.16 mm)
b - 1/32 [.031 in] (0.79 mm) Min

Reassembly

1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
4. Install quad ring over exhaust valve stem until it touches cylinder head with valve closed.

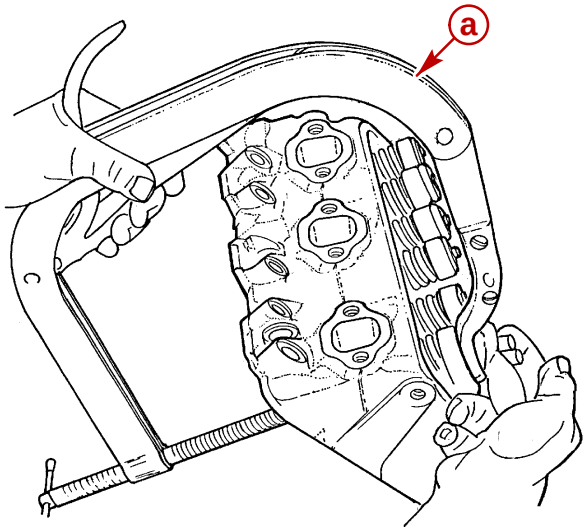
IMPORTANT: The exhaust valve guide seals have been removed. They are replaced with a quad ring as shown below. If repairing heads with seals, replace them with the quad ring upon reassembly.



75307

a - Quad Ring
b - Valve Seal

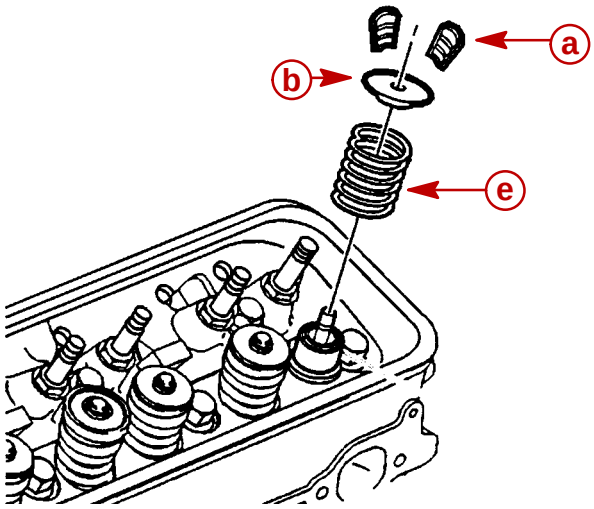
5. Set valve spring (with damper installed) and cap in place.
6. Place retainer on intake valve and/or rotator on exhaust valve.
7. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.



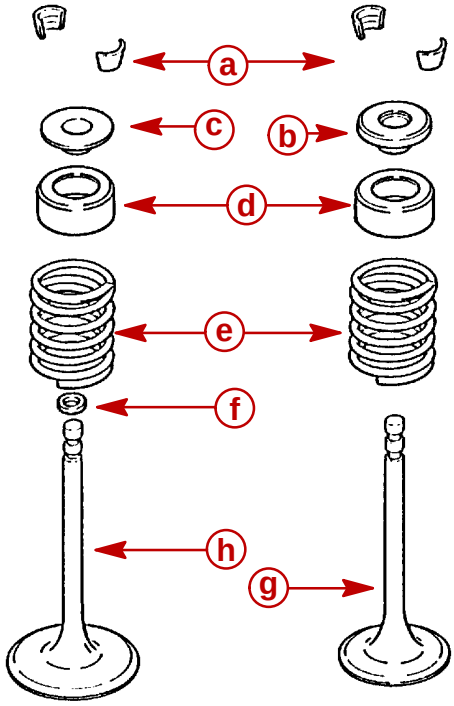
72884

a - Valve Spring Compressor (J-8062)

8. Install valve locks (Quicksilver Needle Bearing Assembly lube may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.



76573

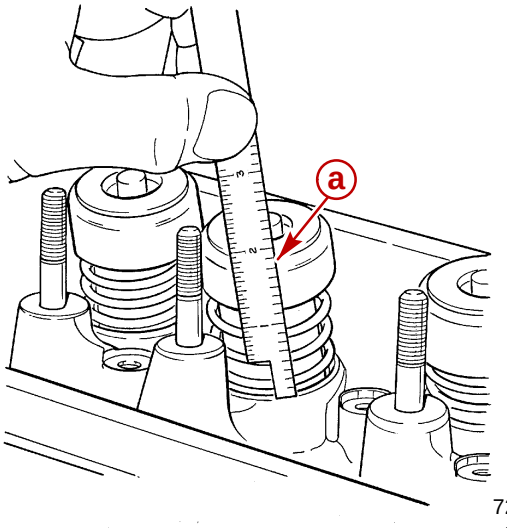


75843

a - Valve Locks
b - Retainer
c - Rotator
d - Cap
e - Valve Stem Oil Seal
f - Outer Spring
g - Intake Valve
h - Exhaust Valve

9. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring, as shown. If measurement exceeds specified height, install a valve spring shim and recheck. DO NOT shim valve springs to give an installed height less than the minimum specified.

05037

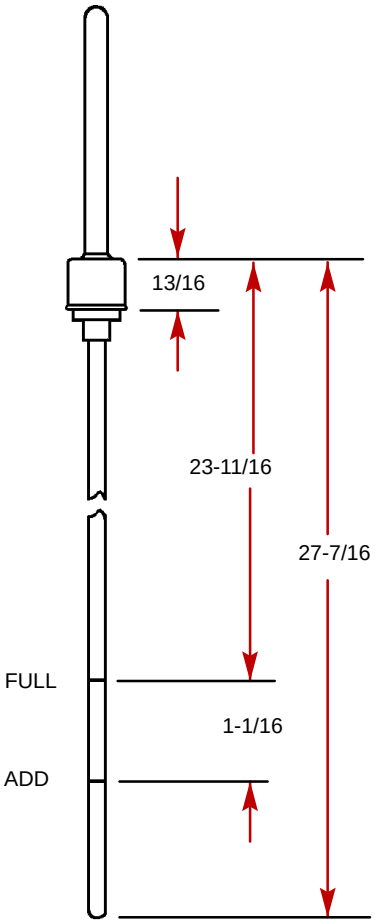


72339

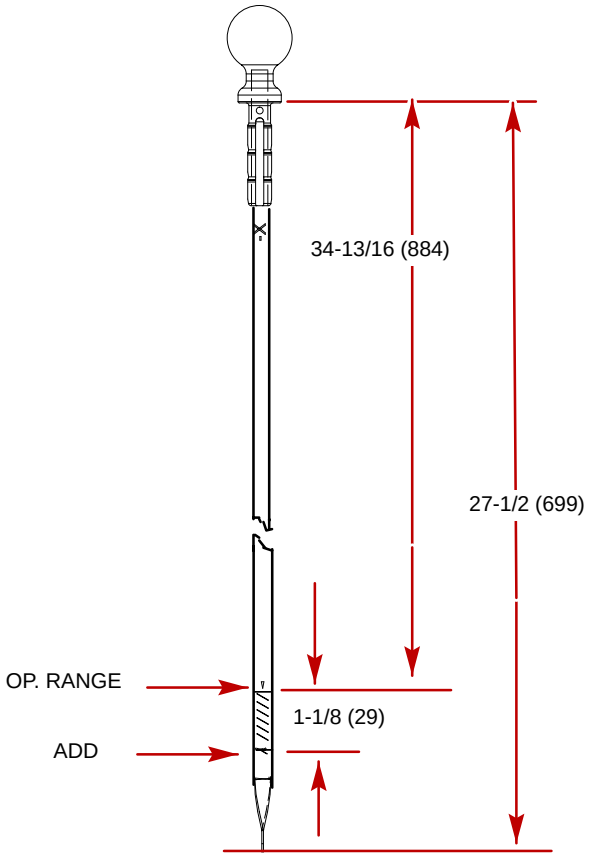
a - Valve Spring Installed Height
b - Cut Away Scale (Grind Out This Portion)

Dipstick Specifications

All Engines



75851



76497

Oil Pan

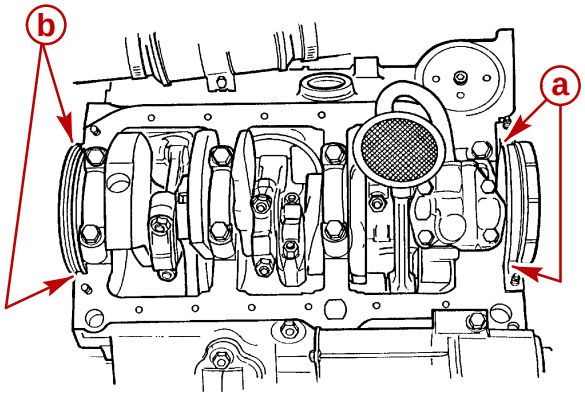
Removal

1. Drain crankcase oil.
2. Remove dipstick and tube.
3. Remove oil pan.

Installation

1. Clean sealing surfaces of engine block and oil pan.
2. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

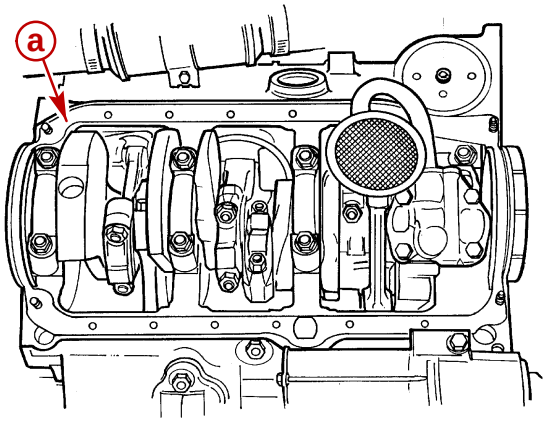


72888

a - Joints of Rear Seal Retainer
b - Joints of Front Cover

3. Install oil pan gasket in position.

NOTE: *A one-piece oil pan gasket may be reused if it is still pliable and is not cracked, torn or otherwise damaged.*



72889

a - Oil Pan Gasket

4. Install oil pan. Starting from the center and working outward in each direction, torque nuts and bolts to 18 lb-ft (25 Nm).
5. Install dipstick tube and dipstick.
6. Fill crankcase with required quantity of oil of specified viscosity. Refer to SECTION 1B - “Maintenance.”

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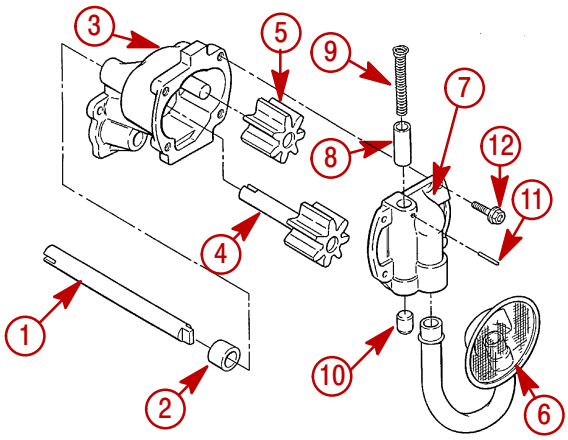
Oil Pump



72145

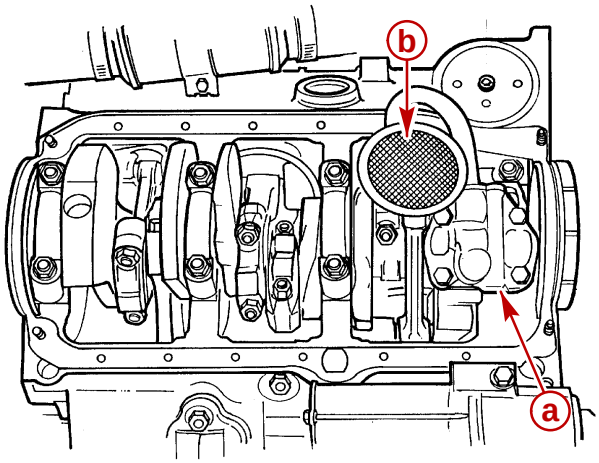
Oil Pump Assembly

1 - Extension Shaft
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Plug
11 - Retaining Pin
12 - Screws

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

Removal

1. Remove oil pan.
2. Remove gasket carefully, the one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn or damaged.



72889

a - Oil Pump
b - Pickup Screen and Pipe

3. Remove oil pump.

Disassembly

1. Remove pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.
3. Remove retaining pin, spring, and pressure regulator valve from pump cover.

IMPORTANT: Do not remove pickup screen and pipe assembly, unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

IMPORTANT: Do not disturb pickup screen on pipe. This is serviced as an assembly.

4. If pickup screen and pipe assembly requires replacement, mount pump in a soft-jawed vise and extract pipe from pump.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

Reassembly

⚠ CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.

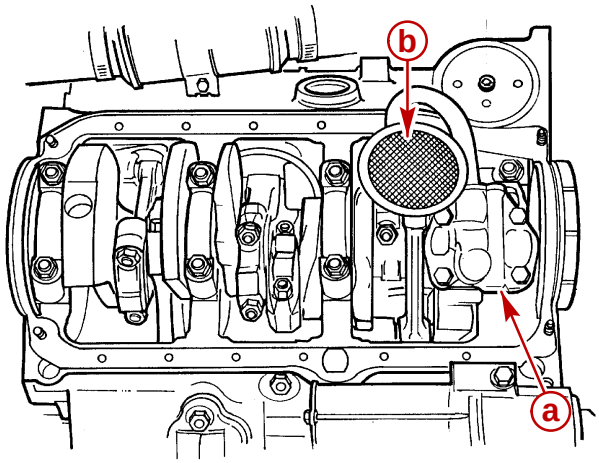
If pickup screen and pipe assembly was removed, mount pump in a soft-jawed vise, apply Quicksilver Perfect Seal to end of new pipe and, using oil pump suction pipe installer (J-21882), tap the pipe in place with a hammer.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Fill gear cavity with engine oil.
5. Install pump cover and torque attaching bolts to 106 lb-in. (12 Nm).
6. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump, with extension shaft, to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Tighten oil pump bolt to 65 lb-ft (88 Nm).



72889

a - Oil Pump
b - Pickup Screen and Pipe

3. Install oil pan. The one-piece oil pan gasket may be reused if still pliable and not damaged.

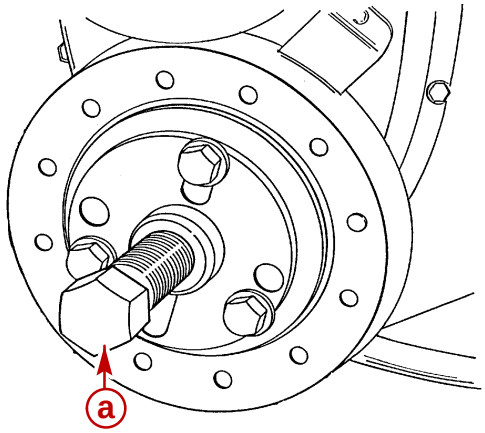
Torsional Damper

Removal

1. Remove drive belt.
2. Remove drive pulley, then remove torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub and use of claw type puller may break the bond.

3. Remove torsional damper with torsional damper remover and installer.



72890

a - Torsional Damper Remover and Installer (J-23523-E)

Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

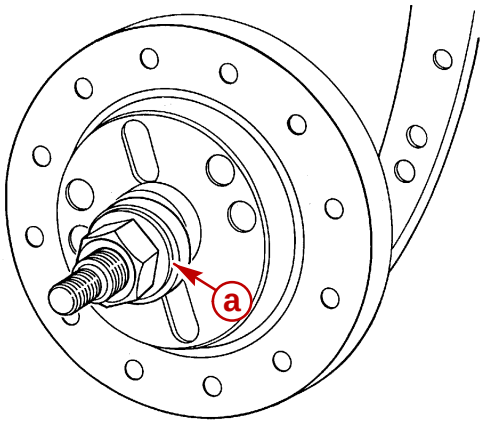
1. Replace key in crankshaft if it is damaged.
2. Coat seal surface of torsional damper with engine oil.
3. Install torsional damper on crankshaft, using torsional damper remover and installer as follows:

   b. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

   c. Install plate, thrust bearing, washer and nut on rod.

   d. Install torsional damper on crankshaft by turning nut until it contracts.



72346

a - Torsional Damper Remover and Installer (J-23523-E)

   b. Remove tool from crankshaft.

   c. To prevent oil leakage, apply Quicksilver RTV sealant to torsional damper keyway.

   d. Install torsional damper bolt. Torque to 74 lb-ft (100 Nm).

4. Install drive pulley(s). Torque bolts to 35 lb-ft (48 Nm).
5. Install and adjust drive belt.

Crankcase Front Cover Oil Seal

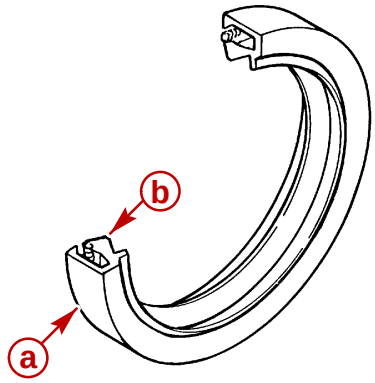
Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft.

INSTALLATION

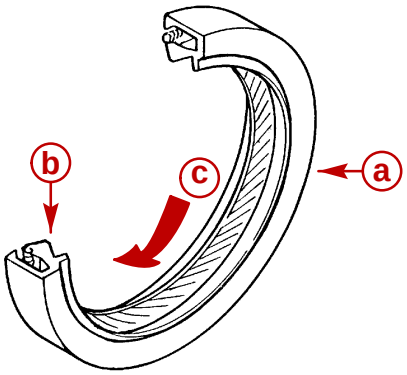
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73123

Front Seal WITHOUT Helical Grooves

- **a** - Can Be Used on Any Rotation Engine
- **b** - Seal Lip Toward Inside of Engine

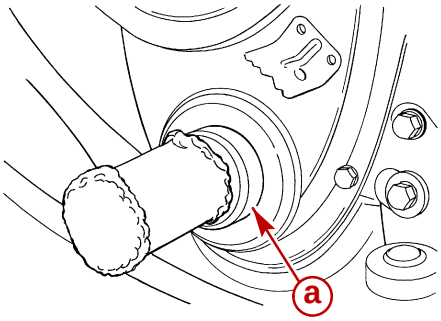


73124

Front Seals WITH Helical Grooves

- **a** - MCM (LH) Rotation Engines
- **b** - Seal Lip Toward Inside of Engine
- **c** - Rotation of Crankshaft as Viewed from Front End Looking Toward Flywheel End

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.
2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just contracts. Do not use excessive force.



72347

a - Crankcase Front Cover Seal Installer (J-35468)

3. Reinstall torsional damper.

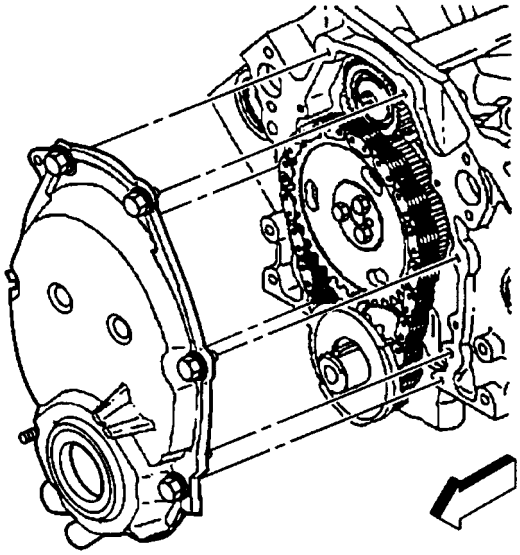
Crankcase Front Cover

Removal

1. Remove engine from boat if necessary to gain access to cover.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

4. Remove crankcase front cover.



76577

5. Drive oil seal out of front cover (from the rear) using a punch.

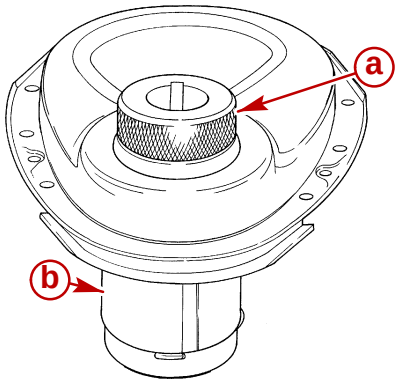
Cleaning and Inspection

1. Clean old gasket material and sealer from mating surface on cylinder block.
2. Surfaces must be clean and flat or oil leakage may result.

Installation

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

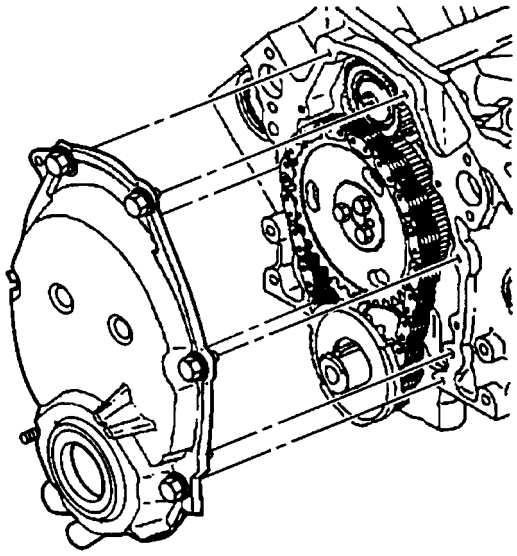
1. Install oil seal in cover with lip of seal toward inside of engine, using crankcase front cover seal installer. To prevent distortion support cover around seal area with an appropriate tool as shown.



72348

a - Crankcase Front Cover Seal Installer (J-35468)
b - Support

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to 100 lb-in. (11 Nm).



76577

4. Install oil pan and torsional damper.
5. Install water circulating pump.
6. Install engine in boat.
7. Fill crankcase with engine oil.

Index

8. Follow procedures in SECTION 6A or 6B of this manual:

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (Refer to SECTION 6A).

Closed Cooled Models: Refill closed cooling section (Refer to SECTION 6B), and provide adequate water supply to seawater pickup.

⚠ CAUTION

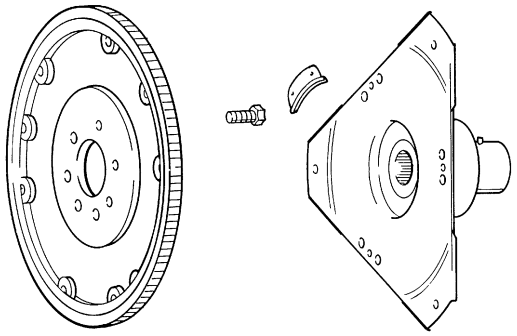
Ensure that cooling water supply is available before starting the engine.

9. Start engine and check for water and oil leaks.

Flywheel

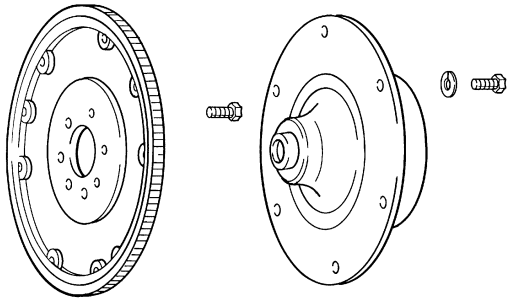
Removal

1. Remove engine from boat. Refer to SECTION 2 - “Removal and Installation”.
2. Refer to “Flywheel Housing” description in this section and remove flywheel housing and related parts.
3. Remove coupler.
4. Remove flywheel.



72349

Alpha One Coupler



72350

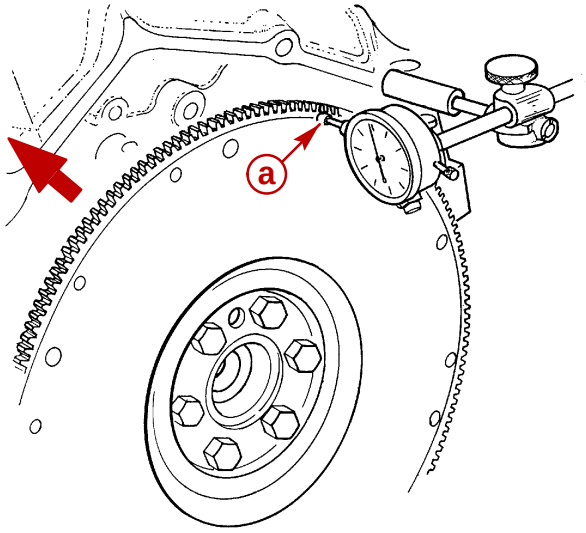
Bravo Coupler

Inspection

1. Inspect splines in coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.

Installation

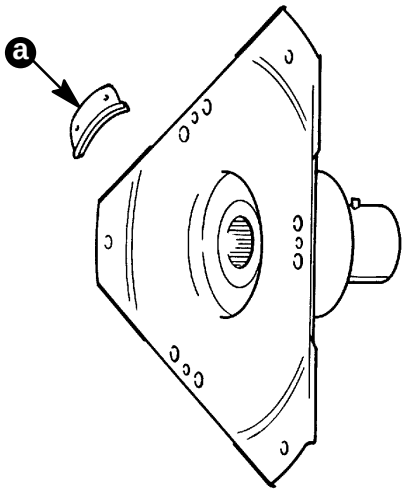
1. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.
2. Aligning dowel hole in flywheel with dowel in crankshaft, install flywheel. Torque bolts to 75 lb-ft (100 Nm).
3. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block.
   b. Take readings around outer edge of flywheel. Push in on flywheel as far as it will go to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).



72353

a - .008 In. (0.203 mm) Max Runout

IMPORTANT: Insert three rubber bumpers in Alpha coupler before installation on flywheel.



72354

a - Rubber Bumper

4. Install drive coupler. Torque bolts to 35 lb-ft (48 Nm).
5. Install flywheel housing and related parts. Torque bolts to 30 lb-ft (41 Nm).
6. Install flywheel housing cover. Torque bolts to 80 lb-in. (9 Nm).
7. Refer to SECTION 2 “Removal and Installation” and install engine.

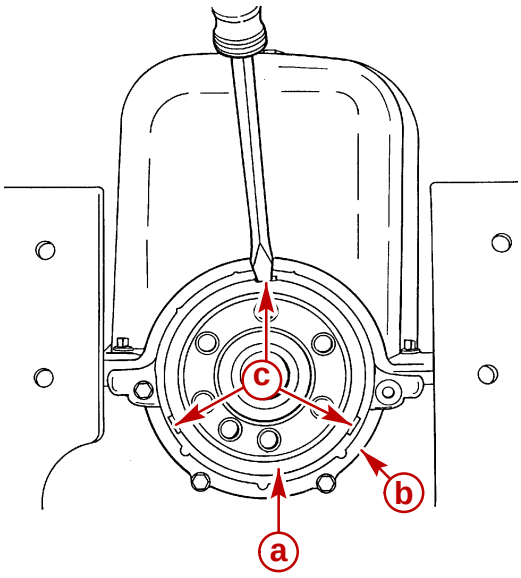
Index

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

Remove seal by using a screwdriver to pry it out of retainer as shown.



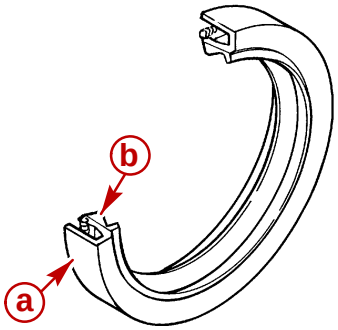
72355

a - Rear Seal
b - Seal Retainer
c - Slots (Three)

Cleaning and Inspection

Clean crankshaft/seal running surface and seal retainer.

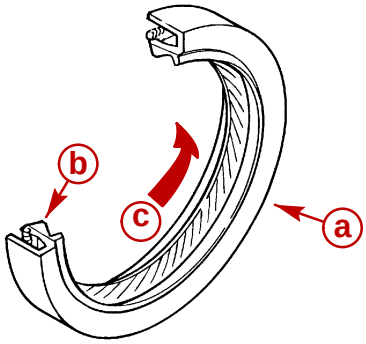
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73126

Rear Seal WITHOUT Helical Grooves

a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside Of Engine



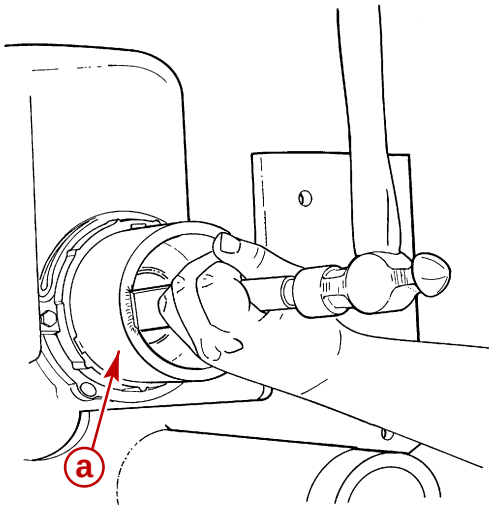
73127

Rear Seal WITH Helical Grooves

a - MCM (LH) Rotation Engines
b - Seal Lip Toward Inside Of Engine
c - Rotation Of Crankshaft As Viewed From Flywheel End Looking Forward

Installation

1. Apply Quicksilver Perfect Seal to seal retainer mating surface. Apply grease to seal lips.
2. Install seal using rear main seal installer. (J-26817-A)



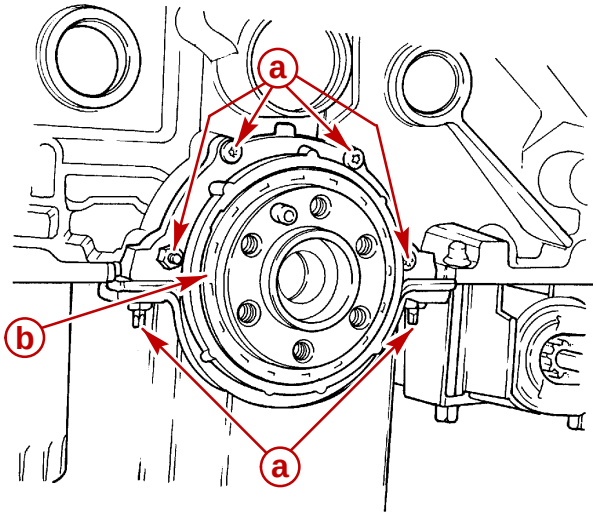
72356

a - Rear Main Seal Installer

Rear Main Oil Seal Retainer

Removal

1. Remove oil pan.
2. Remove oil seal retainer fasteners.
3. Remove oil seal retainer.



72464

a - Fasteners
b - Oil Seal Retainer

Cleaning and Inspection

1. Clean gasket material from mating surfaces.
2. Inspect oil seal retainer for cracks or scored surface.
3. Inspect oil seal for worn, dry or torn rubber. Replace if necessary, refer to “Rear Main Oil Seal.”
4. Inspect alignment pin for damage; replace if necessary.

Installation

1. Coat seal lips with clean 30W motor oil.
2. Install gasket and oil seal retainer with rear main seal.
3. Coat threads of oil seal retainer fasteners with Loctite Pipe Sealant with Teflon.
4. Install fasteners and torque to 133 lb-in.(15 Nm).
5. Install oil pan fasteners. Torque engine oil pan nuts and bolts 18 lb-ft (25 Nm).

NOTE: *A one-piece oil pan gasket may be reused if it is still pliable and is not damaged.*

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .010 in. and .020 in. undersize.

Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one half of a standard insert with one half of a .001 in. undersize insert which will decrease the clearance .0005 in. from using a full standard bearing.

IMPORTANT: If crankshaft has an undersize journal and a new bearing is required, journal must be reconditioned to accept a .010 or .020 in. undersize bearing as .009 in. undersize bearings are not available for service.

Inspection

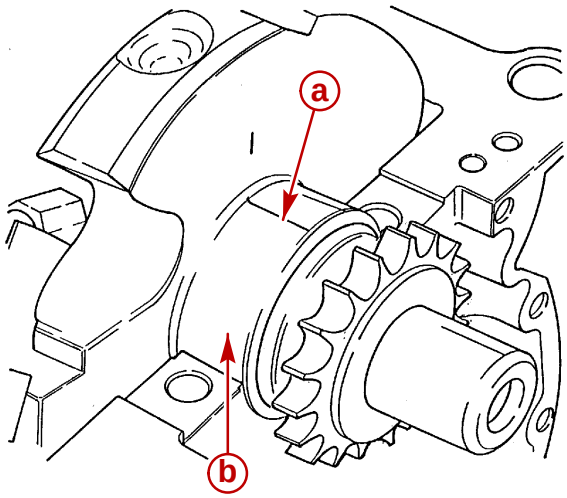
In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If, upon inspection, the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Checking Clearances

To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To ensure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, before to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.



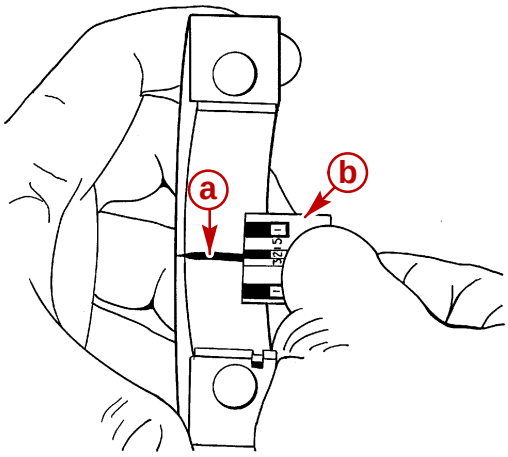
72357

a - Gauging Plastic
b - Journal

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gauge.

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope.



72358

a - Compressed Gauging Plastic
b - Graduated Scale

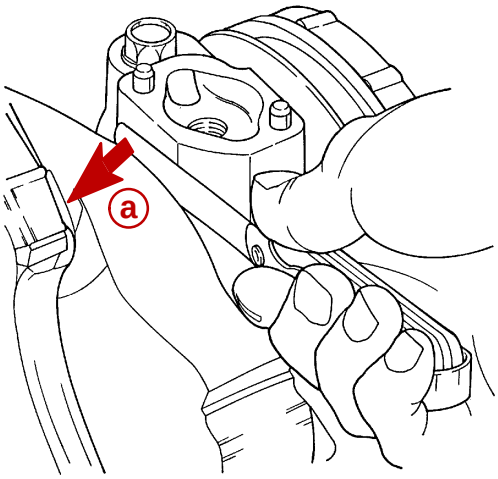
NOTE: *Normally main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal: If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure. If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard, or .001 in., undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

   c. After selecting new bearing, recheck clearance.

8. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to see that there is no excessive drag. When checking No. 1 main bearing, loosen accessory drive belts to prevent tapered reading with plastic gauge.

9. Measure crankshaft end play by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown [Specifications - .002-.006 (0.06-0.15)].

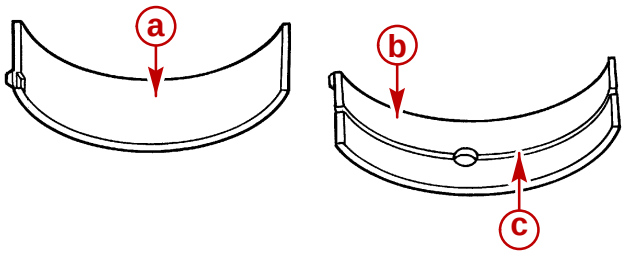


72360

a - Force Crankshaft to Extreme Forward Position

Replacement

NOTE: *Main bearings may be replaced with or without removing crankshaft.*



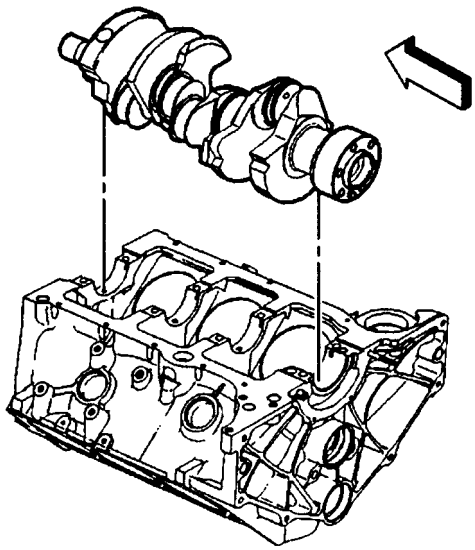
72359

Main Bearing Inserts

a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

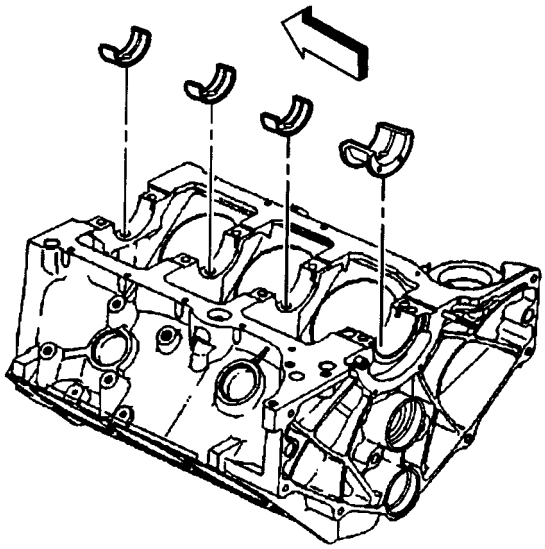
WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft.



76580

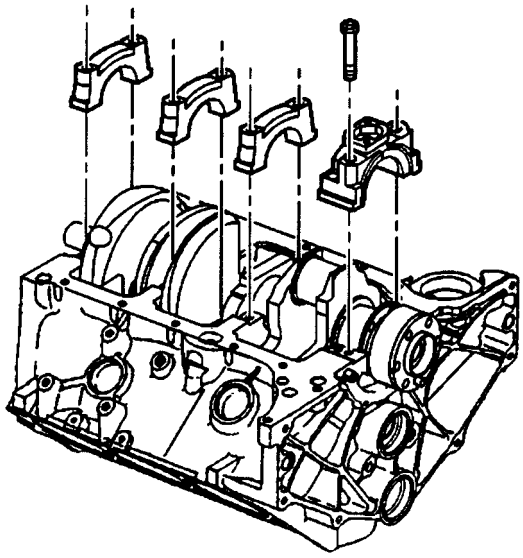
2. Remove the main bearings from the cylinder block and main bearing caps.



76582

3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.

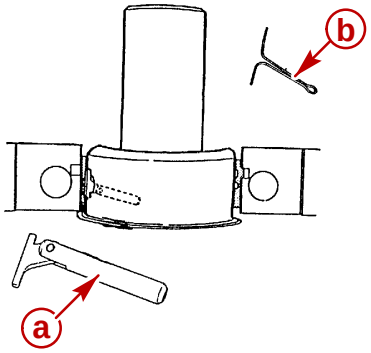
4. Install the crankshaft.



76579

WITHOUT CRANKSHAFT REMOVED

1. With oil pan, oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Install main bearing remover/installer in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent, as shown, to do the job.



72622

a - Main Bearing Remover/Installer (J-8080)
b - Cotter Pin

3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
4. Oil new selected size upper bearing and insert plain (un-notched) end between crankshaft and indented or notched side of block. Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
5. Oil new lower bearing and install in bearing cap.
6. Install main bearing cap with arrows pointing toward front of engine.
7. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to 75 lb-ft (102 Nm). Torque rear main bearing cap to 10-12 lb-ft (14-16 Nm); then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Torque rear main bearing cap to 75 lb-ft (102 Nm).

Connecting Rod Bearings

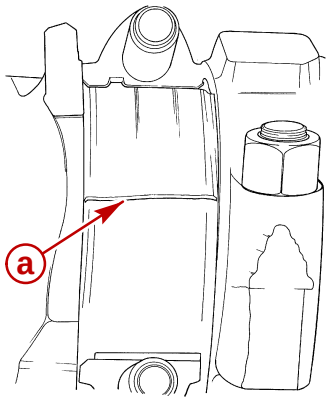
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts, and in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

On removing a connecting rod cap, it is possible to find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

Inspection and Replacement

IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.

1. With oil pan and oil pump removed, remove the connecting rod cap and bearing.
2. Inspect the bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
3. Wipe both upper and lower bearing shells and crankpin clean of oil.
4. Measure the crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round .001 in., interference between the bearing and crankpin will result in rapid bearing failure.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown. Position the gauging plastic in the middle of the bearing shell. (Bearings are eccentric and false readings could occur if placed elsewhere.)



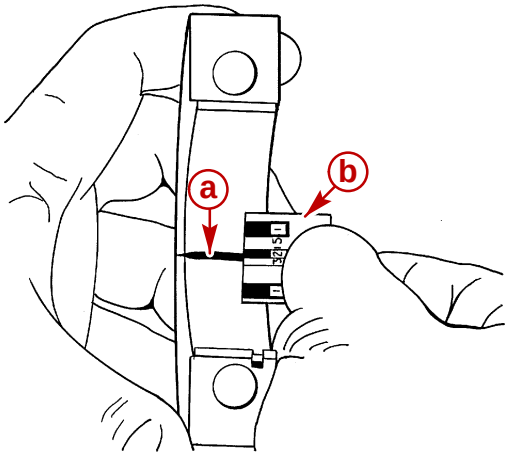
72361

a - Gauging Plastic

   b. Install the bearing in the connecting rod and cap.
   c. Install the bearing cap and evenly torque nuts to 45 lb-ft (61 Nm).

IMPORTANT: Do not turn the crankshaft with the gauging plastic installed.

d. Remove the bearing cap and using the scale on the gauging plastic envelope, measure the gauging plastic width at the widest point as shown.

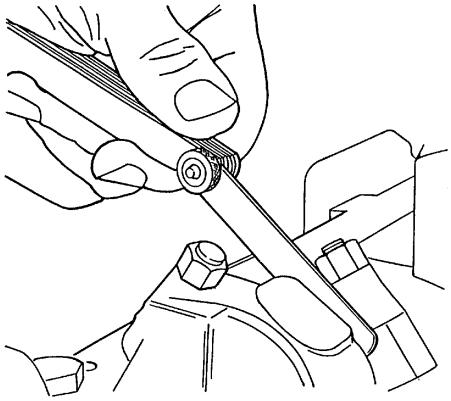


72358

6. If the clearance exceeds specifications, select a new, correct size bearing and measure the clearance.

NOTE: *Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.*

7. Coat the bearing surface with oil, install the rod cap and torque nuts to 45 lb-ft (61 Nm).
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances between connecting rod caps as shown [Specifications - .006-.014 (0.152-0.356)].

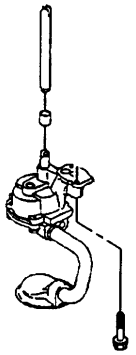


72891

Connecting Rod/Piston Assembly

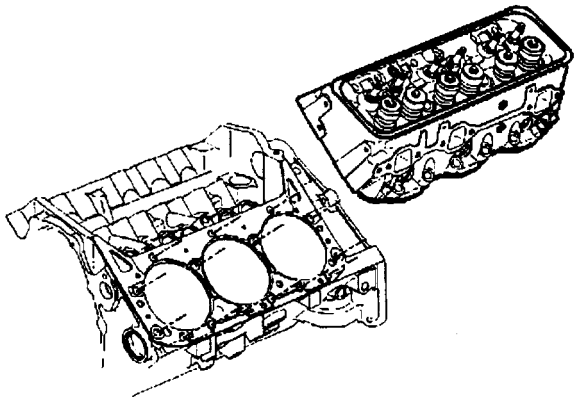
Removal

1. Remove oil pan and dipstick tube.
2. Remove oil pump.



76571

3. Remove distributor and intake manifold.
4. Remove cylinder heads.



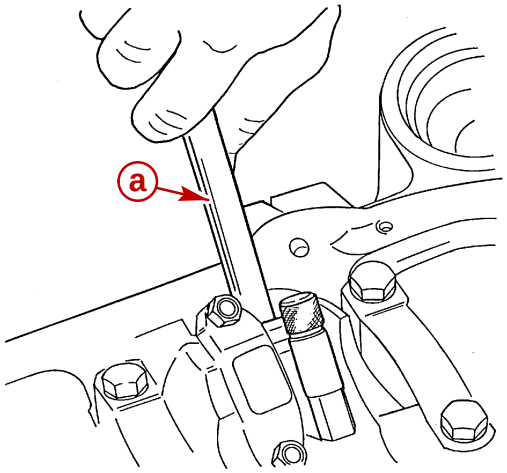
76576

5. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and / or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

6. Mark connecting rods and bearing caps (left bank 1, 3 and 5; right bank 2, 4 and 6 from front to rear on same side as piston thrust).
7. Remove connecting rod cap and install connecting rod bolt guide (3/8-24) on bolts. Push connecting rod and piston assembly out of top of cylinder block.

NOTE: *It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.*

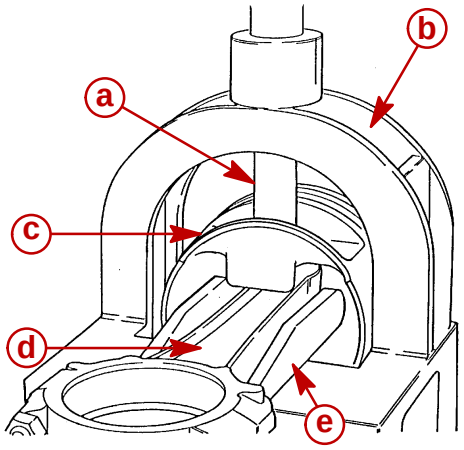


72892

a - Connecting Rod Bolt Guide (3/8-24) [J-5239]

Disassembly

Disassemble piston from connecting rod using piston pin remover.



72893

a - Piston Pin Remover (J-24086-B)
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Cleaning and Inspection

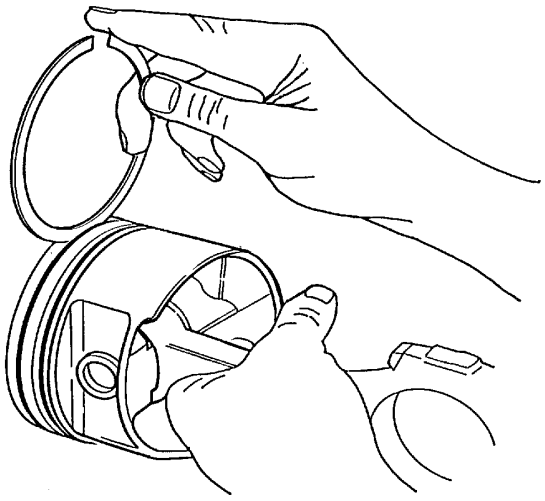
CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

PISTONS

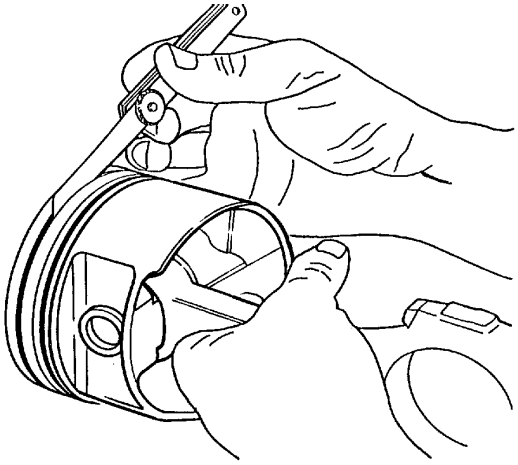
NOTE: *Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

1. Clean varnish from piston skirts with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes are clean.
2. Inspect piston for damaged ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts and eroded areas at top of piston.
3. Inspect grooves for nicks and burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under “Piston Selection.”
5. Slip outer surface of a new top and second compression ring into respective piston ring groove and roll ring entirely around the groove to make sure that ring does not bind. If ring groove causes binding, remove by dressing with a fine cut file. If a distorted ring causes binding, recheck with another ring.



72894

6. Proper clearance of piston ring in its groove is necessary for proper ring action. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See “Specifications.”



72895

PISTON PINS

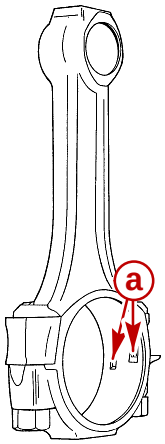
1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish and scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001 in. (0.02 mm) wear limit, replace piston and piston pin assembly.

Reassembly

PISTONS AND PISTON PINS

IMPORTANT: When reassembling pistons and connecting rods, be aware that:

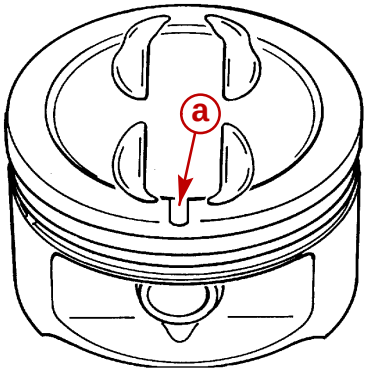
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**



72368

a - Rod Bearing Tangs

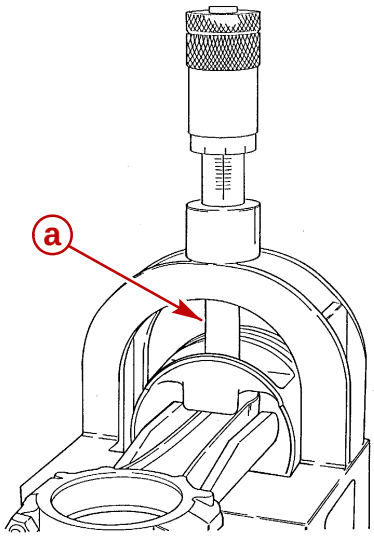
IMPORTANT: Notch in piston must be positioned facing toward the front of the engine.



72896

a - Notch

1. Assemble piston to connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72897

a - Piston Pin Remover (J-24086-B)

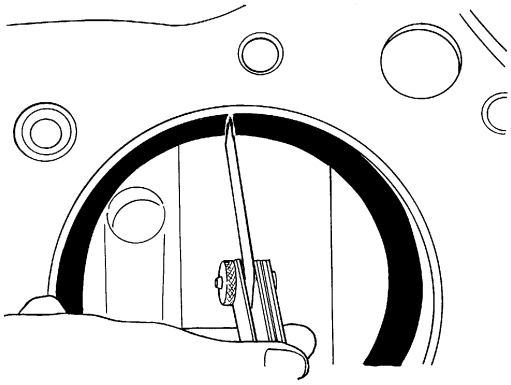
2. Once assembled, check piston for freedom of movement in all directions on connecting rod; piston should move freely. If it does not, piston pin bore is tight and piston/pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge as shown.



72372

4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons.

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7. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends together and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is not binding. If ring groove is causing binding, remove with a fine cut file. If a distorted ring is causing binding, use a new ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

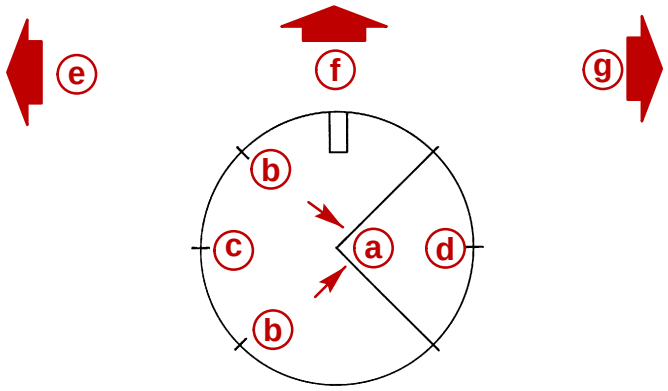
   e. Install lower compression ring with marked side up, using ring expander.
   f. Install top compression ring with marked side up, using ring expander.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install connecting rod bolt guide (3/8-24) (J-5239) on connecting rod bolts.

IMPORTANT: Be sure ring gaps are properly positioned as shown.



72373

Ring Gap Location

- **a** - Oil Ring Spacer Gap (Tang In Hole Or Slot Within Arc)
- **b** - Oil Ring Gaps
- **c** - 2nd Compression Ring Gap
- **d** - Top Compression Ring Gap
- **e** - Port Side
- **f** - Engine Front
- **g** - Starboard Side

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use piston ring compressor to compress rings. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

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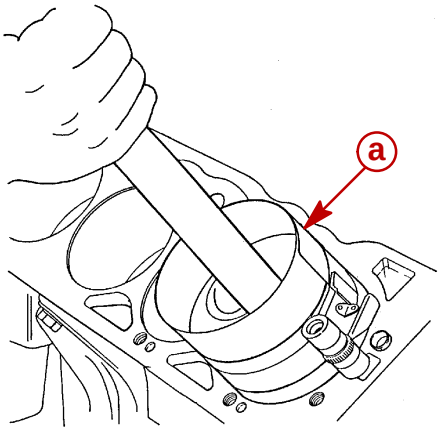
IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3 and 5 in left bank and 2, 4 and 6 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.



72552

a - Piston Ring Compressor (J-8037)

5. Remove connecting rod bolt guide.
6. Install bearing caps and torque nuts to 20 lb-ft (27 Nm), then tighten nuts an additional 70 degrees angular torque using a Torque Angle Gauge.
7. Check connecting rod side clearance.

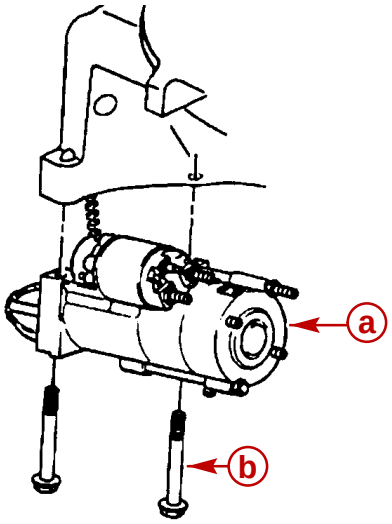
NOTE: *If bearing replacement is required, refer to "Connecting Rod Bearings."*

8. Install oil pump.
   a. Install dipstick and oil pan.
   b. Install cylinder heads.
   c. Install intake manifold.
   d. Install distributor.
9. Fill crankcase with oil. Refer to SECTION 1 - "Maintenance."
10. Torque rocker arm nuts to 22 lb-ft (30 Nm).

Crankshaft

Removal

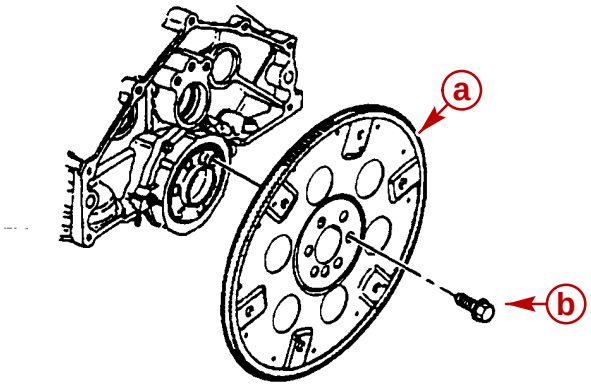
1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove starter.



76489

a - Starter
b - Mounting Bolts

4. Remove flywheel housing.
5. Remove drive coupler and flywheel.



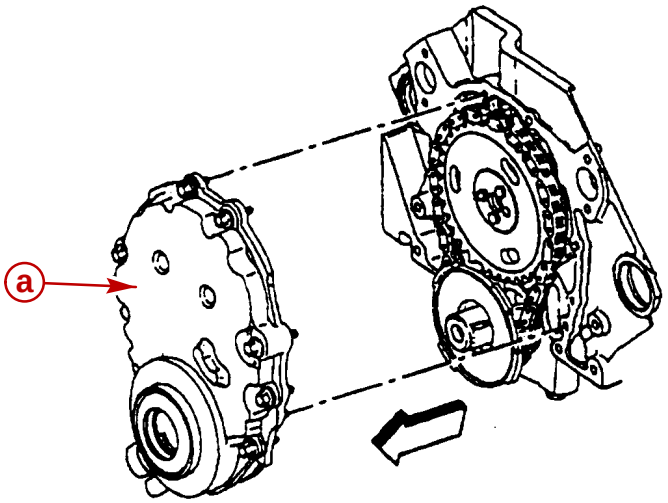
76490

a - Flywheel
b - Bolts

6. Remove belts.
7. Remove water pump.
8. Remove crankshaft pulley and torsional damper.
9. Remove spark plugs.
10. Remove oil pan and dipstick tube.
11. Remove oil pump.

Index

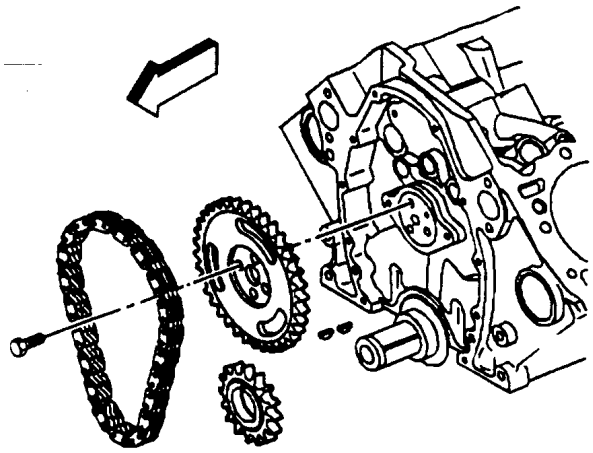
12. Timing chain cover.



76491

a - Timing Chain Gear Cover

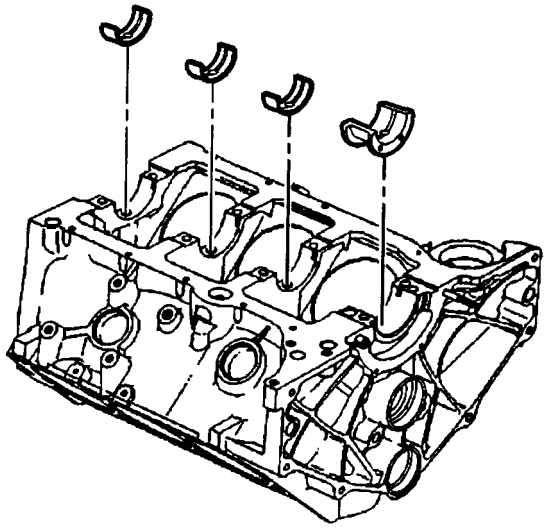
13. Turn crankshaft to align timing mark with camshaft mark.
14. Remove camshaft sprocket.



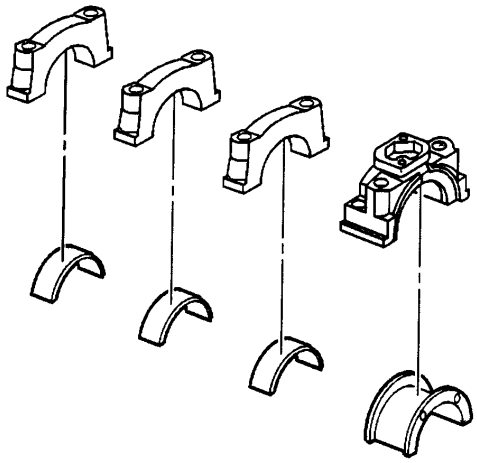
76488

15. Remove rear main seal and retainer.
16. Make sure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.
17. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
18. Remove main bearing caps and carefully lift crankshaft out of cylinder block.

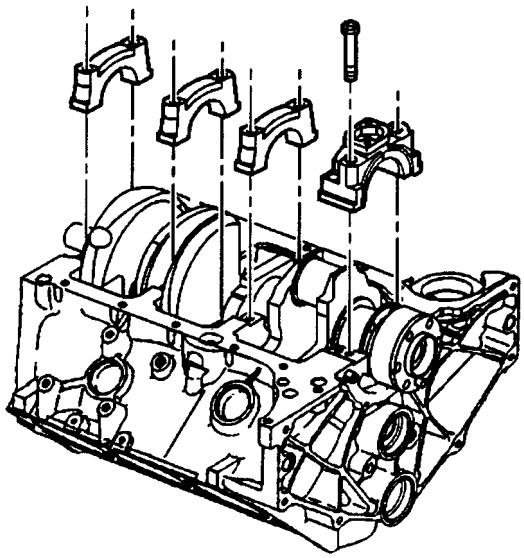
19. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined.



76582



76581



76579

Cleaning and Inspection

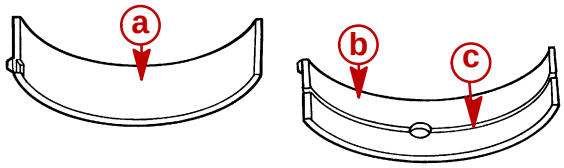
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize. Refer to “Specifications.”
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator. Refer to “Specifications.”
4. Replace or recondition crankshaft if not within specifications.

Installation

1. If a new crankshaft is being installed, remove timing sprocket from old crankshaft and reinstall on new crankshaft as outlined.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

2. Install main bearings in engine block as follows.



72359

Main Bearing Inserts

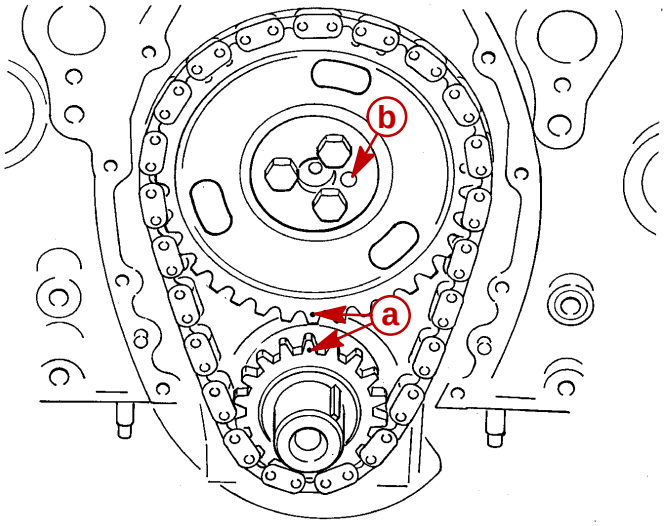
a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

3. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
4. Check clearance of each main bearing. If bearing clearances are satisfactory, apply engine oil to journals and bearings.
5. Install main bearing caps. Torque bolts to 75 lb-ft (102 Nm). Refer to “Main Bearings” when tightening rear main bearing cap.
6. Check crankshaft end play.
7. Install rear main seal retainer and seal. Torque fasteners to 133 lb-in. (15 Nm).
8. Check clearance for each connecting rod bearing. If bearing clearances are satisfactory, apply engine oil to journals and bearings.
9. Install rod caps and torque nuts to 45 lb-ft (61 Nm).
10. Reverse Steps 3 - 13 in Removal.
11. Install new oil filter.
12. Fill crankcase with oil.

Timing Chain and Sprocket

Removal

1. Remove torsional damper, oil pan and crankcase front cover.
2. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment.



72899

a - Timing Marks Aligned
b - Locating Pin

3. Remove camshaft sprocket and timing chain. (If sprocket does not come off easily, a light tap on the lower edge of the sprocket using a plastic mallet, should dislodge it.)
4. Remove crankshaft sprocket if it requires replacement.

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear and damage.
3. Inspect sprockets for wear and damage.

Installation - Timing Chain

1. Install crankshaft sprocket if removed.

⚠ CAUTION

When timing marks are aligned in this procedure, the No. 4 cylinder is on compression (TDC); therefore, if the distributor is to be installed, the rotor MUST BE positioned at the No. 4 post on the distributor cap.

2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down. Align marks on camshaft and crankshaft sprockets.

IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Install sprocket on camshaft. Torque bolts to 18 lb-ft (24 Nm).
4. Lubricate timing chain with engine oil.
5. Install crankcase front cover and torsional damper.

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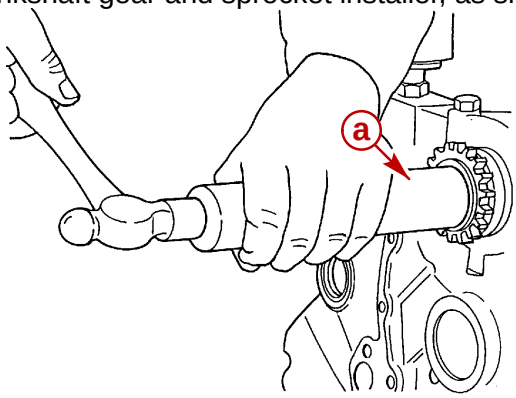
Crankshaft Sprocket

Removal

1. Remove torsional damper and crankcase front cover.
2. Remove camshaft timing chain.
3. Using crankshaft gear and sprocket puller (P/N J-5825-A), remove crankshaft sprocket.

Installation

1. Using crankshaft gear and sprocket installer, as shown, install sprocket on crankshaft.



72377

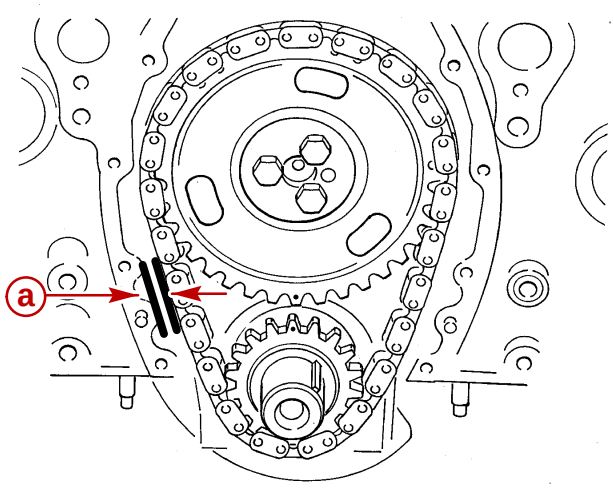
a - Crankshaft Gear and Sprocket Installer (J-5590)

2. Install timing chain.
3. Install crankcase cover and torsional damper.

Checking Timing Chain Deflection

With timing chain and sprockets installed, check timing chain deflection, as follows:

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



72899

a - Reference Point

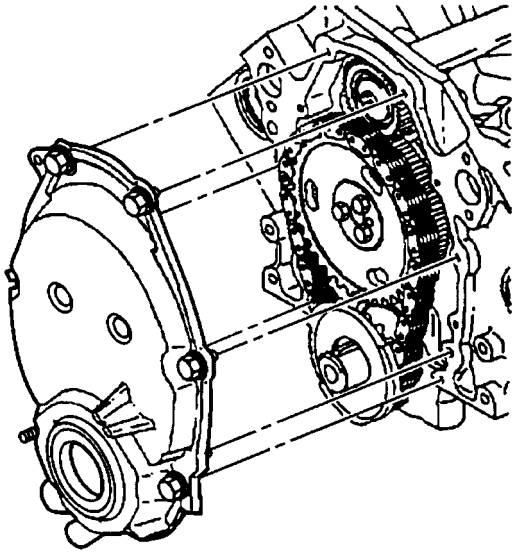
Balance Shaft / Gears

Removal

1. Remove manifold.

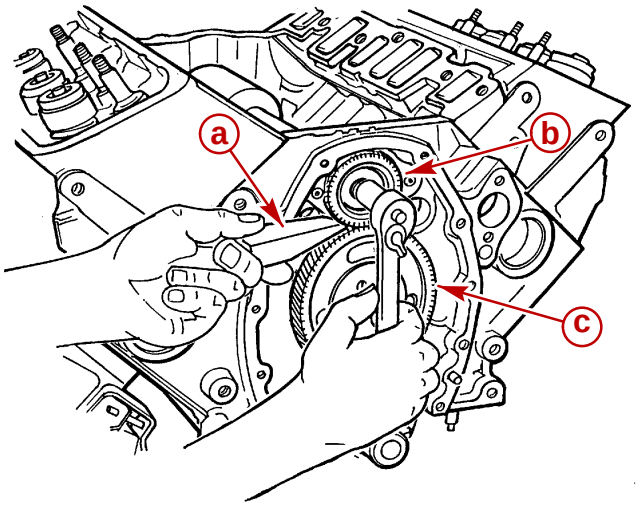
IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

2. Remove crankcase front cover.



76577

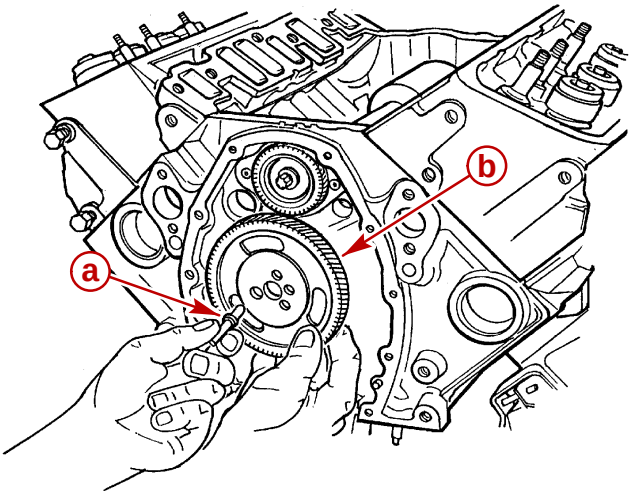
3. Remove timing chain.
4. Insert hard wood wedge between gear teeth and remove TORX bolt retaining balance shaft driven gear. Remove gear.



72900

a - Wedge
b - Driven Gear
c - Drive Gear

5. Unscrew stud and remove balance shaft drive gear on camshaft as shown.



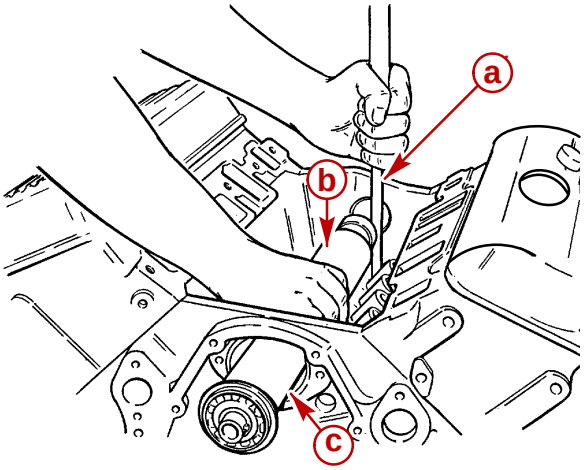
72901

a - Stud
b - Drive Gear

6. Remove two TORX bolts retaining balance shaft thrust plate.

IMPORTANT: Care should be taken in next step as damage to cylinder block and/or balance shaft could result.

7. Insert pry bar in aft section between balance shaft and cylinder block. Gently apply forward pressure and remove balance shaft.

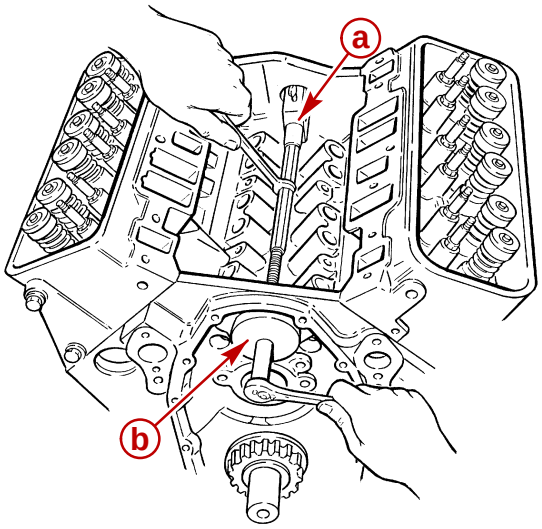


72902

a - Pry Bar
b - Balance Shaft
c - Bearing Housing

NOTE: *When replacing balance shaft rear bearing, place a cloth in valley to prevent any debris from entering the crankcase.*

8. Balance shaft rear bearing can be replaced using balance shaft removal and installer tool in conjunction with bearing puller.



72903

a - Balance Shaft Removal and Installation Tool
b - Bearing Puller

Cleaning and Inspection

1. Wash balance shaft in solvent and blow dry with compressed air.
2. Inspect rear bearing for wear or damage. See “Specifications.”

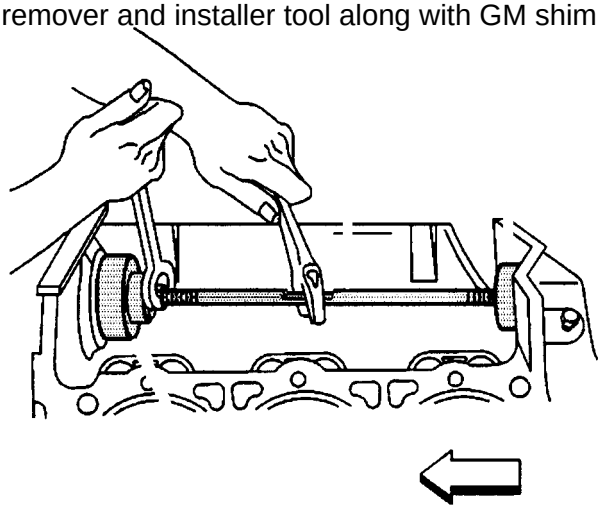
NOTE: *Front bearing is not serviceable and may be replaced only with the balance shaft assembly.*

3. Inspect front bearing for secure fit on shaft or excessive side to side play. Also check for scored bearings or roughness while rotating.
4. Inspect front cylinder block bore for scoring or evidence of bearing spinning in bore.
5. Inspect gears for chips or excessive wear on teeth.
6. Inspect balance shaft gear key way and shaft dowel pin for excessive wear.

Installation

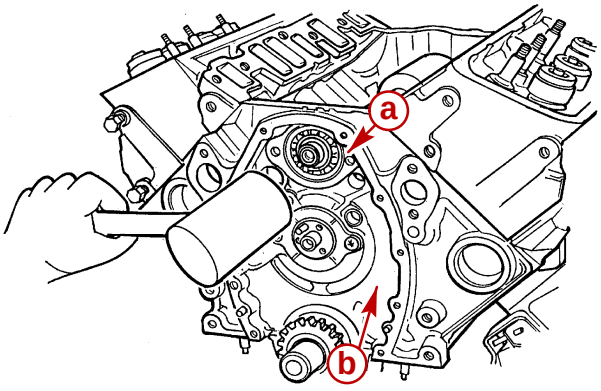
NOTE: *GM shim (10229872) is placed on installer tool prior to the bearing. This will assure proper depth setting of rear bearing when installed.*

1. Use balance shaft remover and installer tool along with GM shim to insert bearing.



76590

2. Lubricate bearings with engine oil and install balance shaft.
3. Using a soft face mallet, tap shaft until front bearing retaining ring seats against cylinder block.

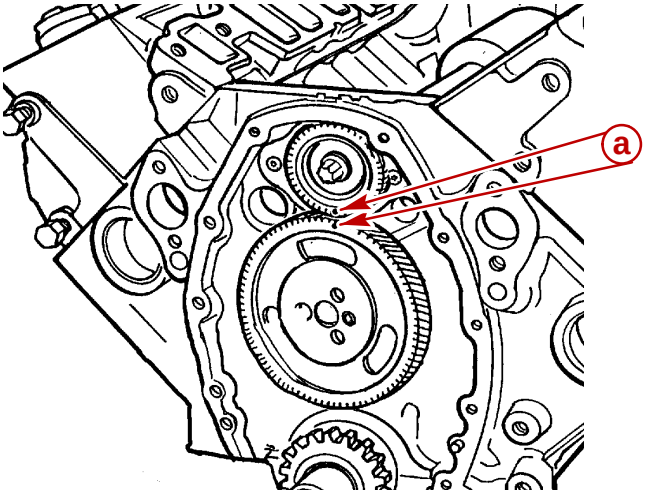


72904

a - Retaining Ring
b - Cylinder Block

4. Install thrust plate and two TORX bolts. Torque to 120 lb-in. (14 Nm).
5. Install driven gear on balance shaft.

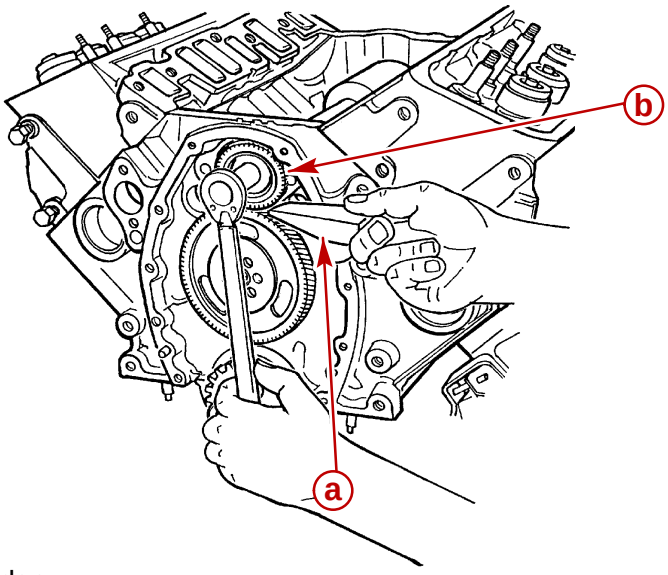
6. Align marks on drive and driven gear and install drive gear on camshaft.



72905

a - Alignment Marks

7. Install bolts to retain camshaft sprocket and torque to 20 lb-ft (27 Nm).
8. Apply thread adhesive to threads of balance shaft bolt and install.
9. Insert hard wood wedge between gear teeth and torque driven gear retaining bolt to 15 lb-ft (20 Nm), then tighten bolt an additional 35 degrees angular torque using a Torque Angle Gauge.



72906

a - Wedge
b - Driven Gear

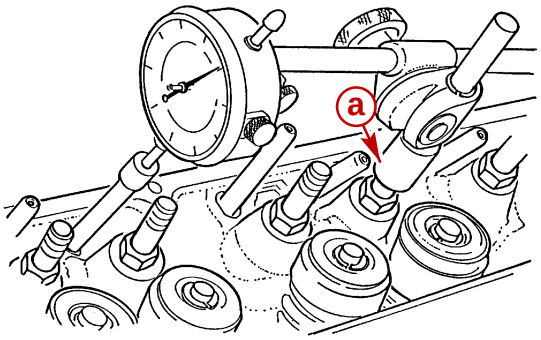
10. Install timing chain.
11. Install crankcase front cover.
12. Install manifold.

Camshaft

Measuring Lobe Lift

NOTE: *Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.*

1. Remove valve mechanism.
2. Position indicator with ball socket adaptor tool on push rod. Ensuer that push rod is in lifter socket.



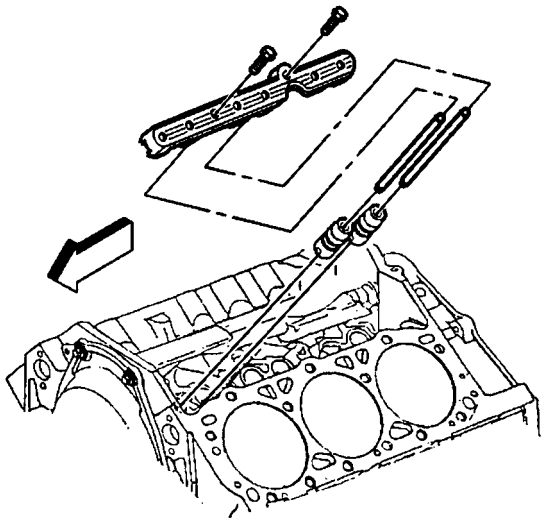
72907

a - Ball Socket Adaptor Tool (J-8520-1)

3. Rotate crankshaft torsional damper slowly in direction of engine rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and “bump” engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with “Specifications.”
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install rocker arm and push rod. Torque nuts to 20 lb-ft (27 Nm).

Removal

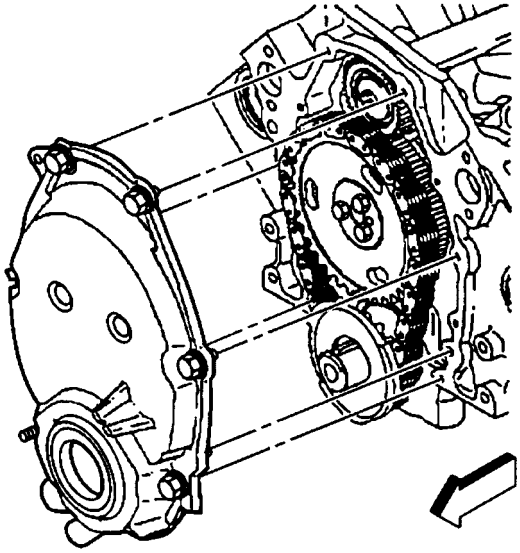
1. Remove valve lifters.



76585

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

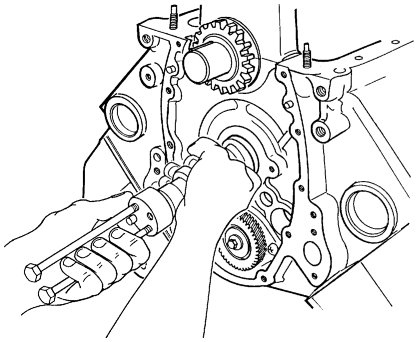
2. Remove crankcase front cover.



76577

3. Remove camshaft as follows:
   a. Remove timing chain, sprocket and camshaft thrust plate.

b. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft as shown.

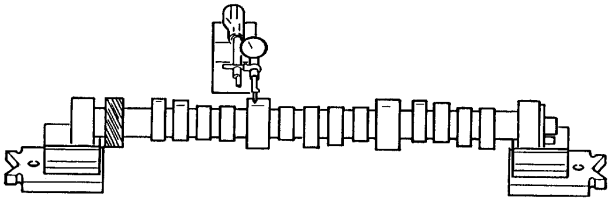


72908

Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If out more than .002 in. (0.05 mm) (dial indicator reading) camshaft should be replaced.



72909

Checking Camshaft Alignment

Installation

1. Install camshaft as follows:
   a. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft. DO NOT damage bearings.
   b. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
   c. Install timing chain.
2. Install crankcase front cover and valve lifters.

Camshaft Bearings

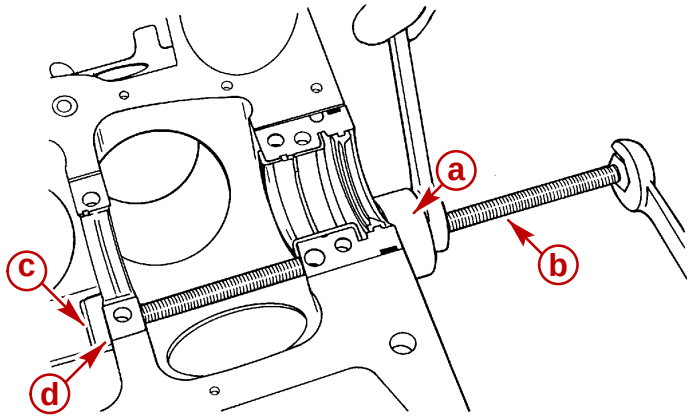
Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

NOTE: *This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of turns to remove all bearings.*

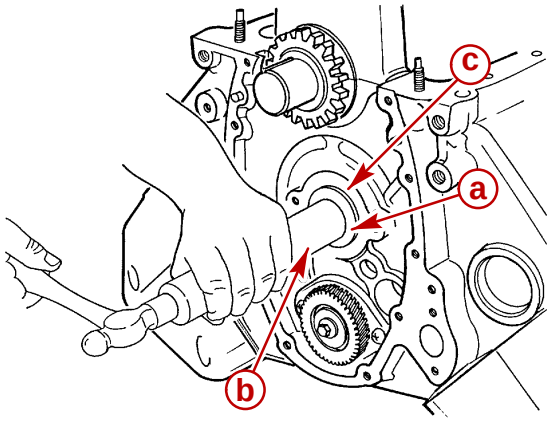
2. Using camshaft bearing remover and installer set (J-6098-01) (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Install tool with shoulder toward bearing. Ensure a sufficient amount of threads are engaged.
4. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in same manner. You must position pilot in rear camshaft bearing to remove rear intermediate bearing.



72383

a - Index Point
b - Puller Screw
c - Driver
d - Bearing

6. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



72870

a - Driver
b - Driver Handle
c - Bearing (Hidden In This View)

Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

- **Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**

1. Installing intermediate and center bearings:
   a. Install nut and thrust washer all the way onto puller screw, then position pilot in front camshaft bearing bore and insert screw through pilot.
   b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.
   c. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.
   d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.

2. Installing front and rear bearings:
   a. Install appropriate size remover and installer tool on drive handle.
   b. Index front bearing (as explained in “Important” above), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.
   c. Install rear bearing in same manner, being sure to index bearing correctly.
3. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft.

Cylinder Block

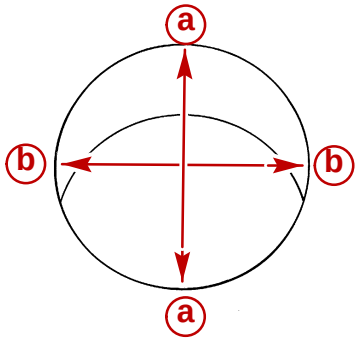
Cleaning and Inspection

1. Remove all engine components.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.
4. Remove expansion plugs.

NOTE: *These plugs may be removed with a sharp punch or they may be drilled and pried out.*

5. Clean and inspect water passages in cylinder block.
6. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.

7. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



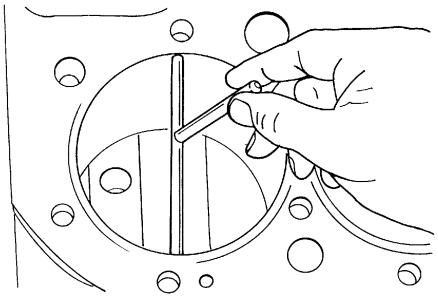
72385

Cylinder Measurement

a - At Right Angle To Centerline Of Engine
b - Parallel to Centerline Of Engine

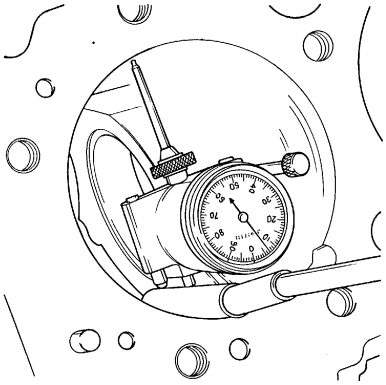
"Out Of Round" Equals The Difference Between "red a" and "red b"

Measurement At Top Of Cylinder Bore and
Measurement At Bottom Of Cylinder Bore



72386

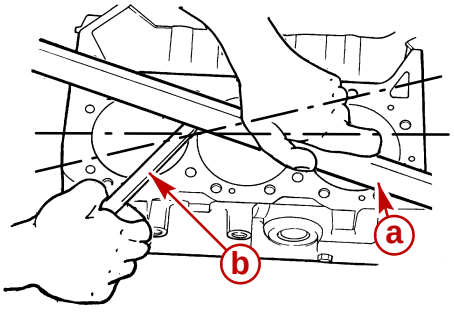
Measuring Cylinder Bore with Telescope Gauge



72387

Measuring Cylinder Bore with Dial Indicator

8. Check cylinder head gasket surfaces for warp with a machinist's straight-edge and a feeler gauge. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.2 mm) overall, block must be resurfaced by an automotive machine shop.



72910

a - Machinist's Straight Edge
b - Feeler Gauge

CYLINDER CONDITIONING

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using a boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt. Boring bar tilt causes the bored cylinder wall to not be at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: *Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection," following.*

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

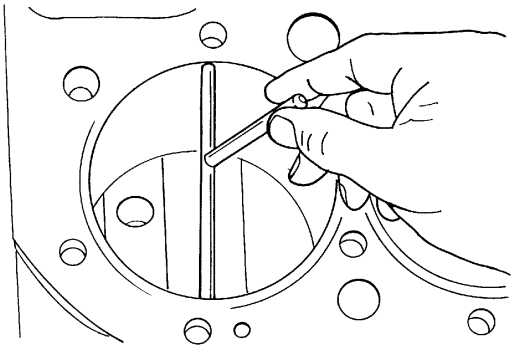
IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

Index

PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as shown.



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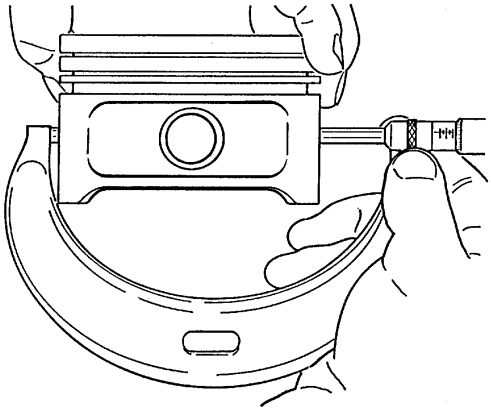
   b. Measure piston diameter at skirt across center line of piston pin as shown.



72911

   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.

Determine if piston-to-bore clearance is in acceptable “Specifications” range.

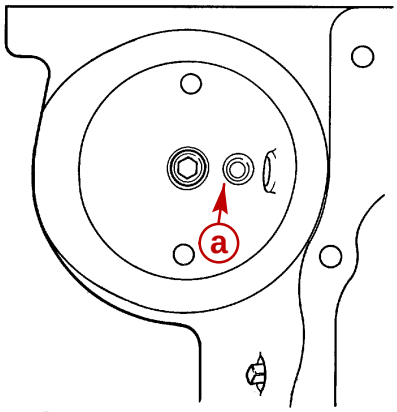
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

Oil Filter By-Pass Valve

Inspection and/or Replacement

Oil by-pass valve should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

1. Remove oil filter from cylinder block and remove by-pass valve.
2. Clean by-pass valve in solvent and blow dry with compressed air.
3. Inspect fiber valve for cracks or other damage. Ensure that valve fits tightly against its seat on the seal. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve should be replaced.



72912

Typical By-Pass Valve

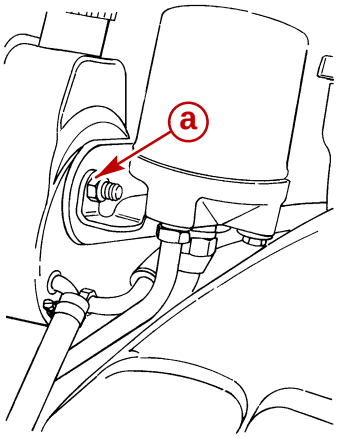
a - Fiber Valve

4. Wipe out valve chamber in cylinder block to remove any foreign material.
5. Install by-pass valve and cylinder block adaptor to engine block.
6. Lubricate oil filter rubber seal and install hand-tight only.

Remote Oil Filter

Inspection and/or Replacement

1. Remove nut from back side of power steering pump bracket.

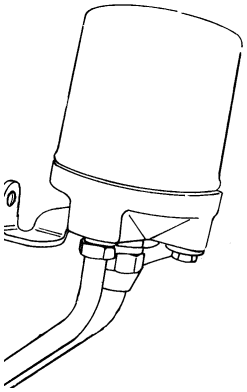


75010

Typical

a - Nut

2. The outer oil line on the oil filter housing must be removed in order to install the bracket.

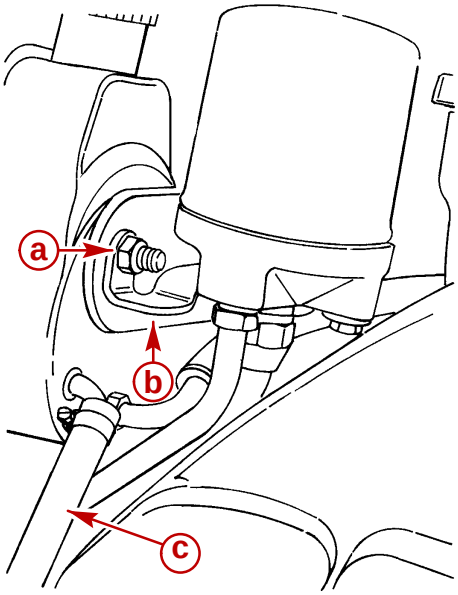


75010

a - Remove This Line

NOTE: *Oil lines must be routed under the return line to the power steering pump. Ensure that the oil lines do not rub or chafe on the exhaust manifold or engine mount.*

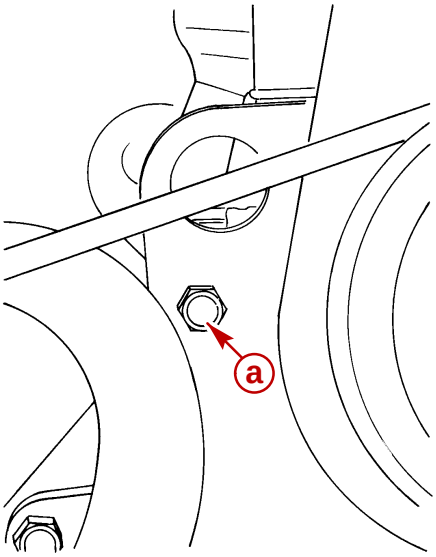
3. Place bracket over the stud and install nut. Torque nut to 12 lb-ft (16 Nm).



75010

a - Bracket
b - Nut
c - Power Steering Return Line

4. Install bracket screw from the front side of power steering bracket.

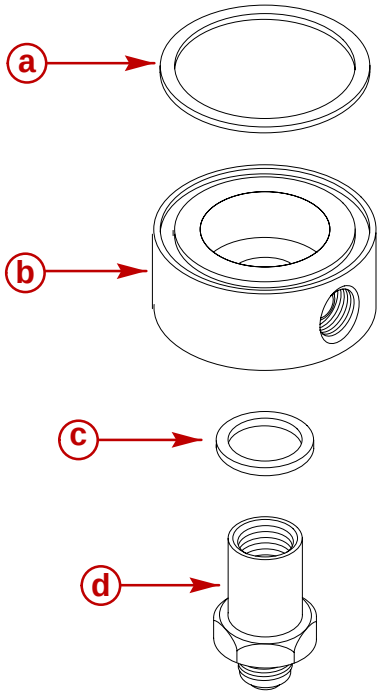


75011

a - Bracket Screw

5. Install previously removed oil line into oil filter housing. Torque fitting 20 to lb-ft (27 Nm).
6. Lightly lubricate seal on oil filter with engine oil. Install oil filter on oil filter adapter. Hand tighten only.
7. Route oil lines past engine mount. Use hose clip to retain hoses. Remove upper screw from port side engine mount. Place hose clip over screw and reinstall screw.

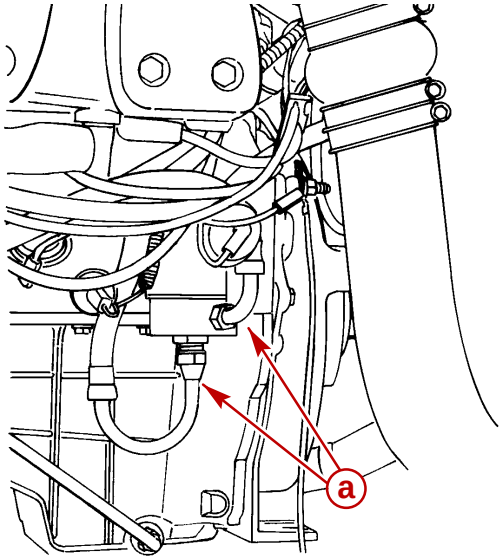
8. Place the seal in adapter and lightly lubricate with engine oil. Position adaptor over engine block and install the bushing in the block. Torque bushing to 40 ft-lb (50 Nm).



75175

a - Engine Block To Adapter Seal
b - Adapter
c - Quad Ring
d - Bushing

9. Install oil lines in adapter and orientate as shown. Torque fittings to 20 lb-ft (27 Nm).



75163

a - Oil Lines

10. Check oil level and fill if necessary.
11. Start engine and check for oil leaks.

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ELECTRICAL SYSTEMS

Section 4A - Starting Systems

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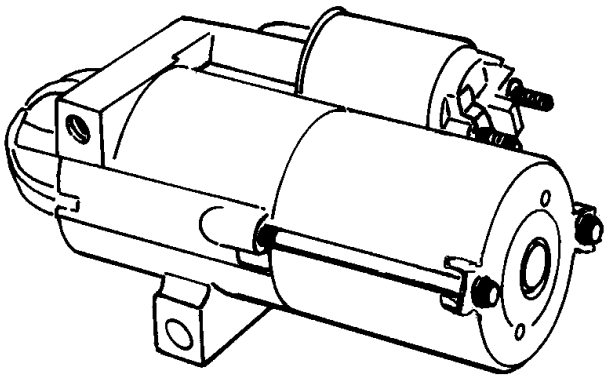
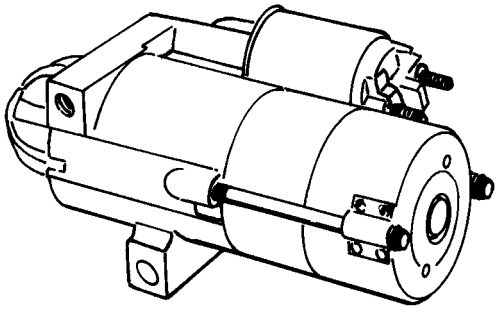
4 A

Identification



75820

Permanent Magnet Gear Reduction (PG260F1) Starter



74041

Delco PG260 Starter

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

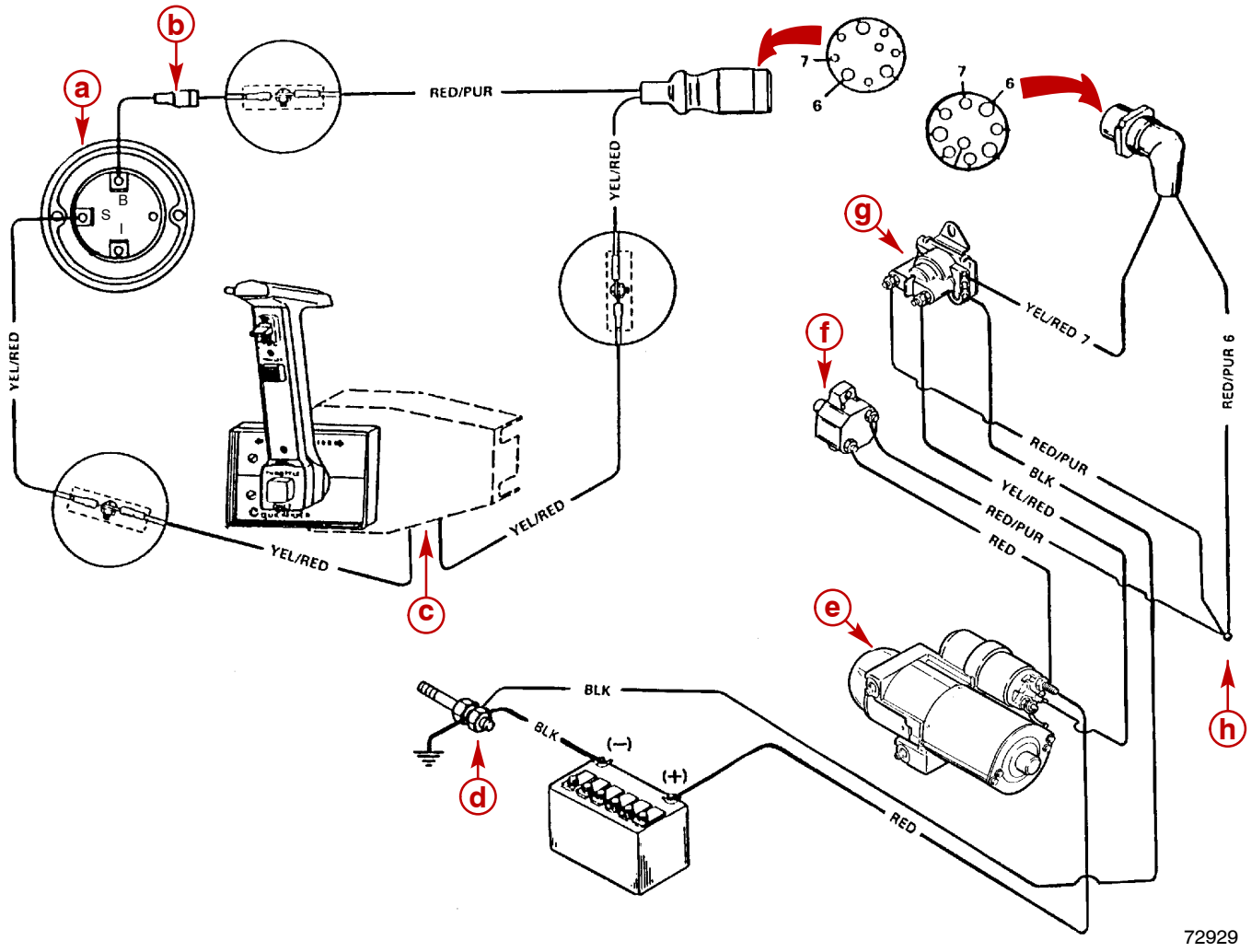
Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

General Precautions

⚠ CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Starting System Components



a - Ignition Switch
b - 20 Amp Fuse
c - Neutral Safety Switch
d - Ground Stud
e - Starter Motor
f - Circuit Breaker
g - Starter Slave Solenoid
h - Wire Junction

Positive Current Flow

This is a general description of the positive current flow, from the battery and through the system until the starter motor cranks.

- Battery to the solenoid switch (on starter) (RED battery cable).
- Solenoid switch to circuit breaker (RED).
- Circuit breaker to wire junction (RED-PUR).
- Wire junction to wiring harness plug (RED-PUR) terminal 6.
- Wiring harness plug to 20 amp fuse (RED-PUR).
- 20 amp fuse to ignition switch terminal I (RED-PUR). At this point ignition switch is turned to START.
- Ignition switch terminal I to terminal C.
- Ignition switch terminal C to neutral start switch (YEL-RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION.
- Neutral start switch to wiring harness plug terminal 7 (YEL-RED).
- Wiring harness plug to starter solenoid (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.
- Starter solenoid is now “closed,” completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED), causing starter motor to crank.

Battery

Battery Cable Recommendations

IMPORTANT: Terminals must be soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do not use acid flux solder as it may cause corrosion and failure.

Cable Length	Cable Gauge	
Up to 3 - 1/2 ft (1.1m)	4	(25 mm^2)
3-1/2 - 6 ft (1.1-1.8m)	2	(35mm^2)
6 ft - 7-1/2 ft (1.8-2.3m)	1	(50mm^2)
7-1/2 - 9-1/2 ft (2.3-2.9m)	0	(50mm^2)
9-1/2 - 12 ft (2.9-3.7m)	00	(70mm^2)
12 - 15 ft (3.7-4.6m)	000	(95mm^2)
15 - 19 ft (4.6-5.8m)	0000	(120m^2)
Both positive (+) and negative (–) cables		

MULTIPLE EFI ENGINE BATTERY PRECAUTIONS

Situation

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for two different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself. The engine will now run normally. This ECM shut down usually happens so fast that the engine just appears to have an ignition miss.

Recommendations

Batteries: Boats with multi-engine EFI power packages require each engine be connected to its own battery. This ensures that the engine's Electronic Control Module (ECM) has a stable voltage source.

Battery Switches: Battery switches should always be positioned so each engine is running off its own battery. DO NOT operate engines with switches in **BOTH** or **ALL** position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

NOTE: *Sure Power Industries Inc., Model 32023A meets this design specification.*

1. The boat may have 2 engines connected to a single Model 32023A battery isolator.
2. The Model 32023A battery isolator is connected to 2 banks of batteries.
3. Each bank contains 2 batteries with the cranking battery for 1 engine in each bank.
4. The second battery in each bank is connected in parallel to the cranking battery.
5. The Model 32023A battery isolator is designed for this type of use; 2 battery banks, 2 charging sources, 120 amps (maximum alternator output).
6. When the engines are running, either engine's alternator could be charging either bank of batteries through the Model 32023A battery isolator.

Any other manufacturer's battery isolator that is the same type as the Sure Power Inc., Model 32023A could also be used.

Generators: The generator's battery should be considered another engine's battery.

Maintenance

⚠ WARNING

DO NOT use jumper cables and a booster battery to start engine. DO NOT recharge a weak battery in the boat. Remove battery and recharge in a well ventilated area away from fuel vapors, sparks or flames.

⚠ WARNING

Batteries contain acid which can cause severe burns. Avoid contact with skin, eyes and clothing. Batteries also produce hydrogen and oxygen gases when being charged. This explosive gas escapes fill/vent caps and may form an explosive atmosphere around the battery for several hours after it has been charged; sparks or flames can ignite the gas and cause an explosion which may shatter the battery and could cause blindness or other serious injury.

Safety glasses and rubber gloves are recommended when handling batteries or filling electrolyte. Hydrogen gases that escape from the battery during charging are explosive. When charging batteries, be sure battery compartment, or area where batteries are located, is well vented. Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

⚠ CAUTION

To prevent damage to the electrical system be sure to adhere to the following:

- **Never disconnect the battery cables while the engine is running.**
- **If a charger or booster is to be used, be sure to connect it in parallel with existing battery (positive to positive and negative to negative).**
- **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**
- **Check battery condition periodically.**
- **Make sure that battery leads are kept clean and tight.**

PERIODIC INSPECTION

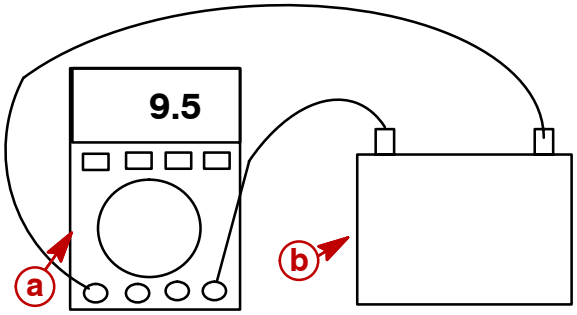
1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Testing

⚠ CAUTION

Test battery in well ventilated area as gases given off by battery are hazardous.

A strong battery must be maintained. If battery shows less than 9.5 volts when under starting load, (at 80° F or 27° C) it should be recharged. Check with DC voltmeter.



76498

a - Voltmeter
b - Battery

Place battery under heavy load (as during engine cranking or with a variable resistor tester) and test cell voltage while under load.

Certain conditions must be met before testing.

- Battery must be 60 to 100°F (16 to 38°C).
- Electrolyte level must be correct in all cells.
- Battery must be at least half charged.
- No obvious defects.

1. Check voltage per manufacturer's specifications.
2. If readings are low, recharge and retest.
3. If readings remain low, battery should be replaced.

Storage

1. Remove battery and clean exterior.
2. Check fluid level and fill if low.
3. Cover terminals and bolts with light coat of grease.
4. Set battery on wood or in carton; store in cool, dry place.
5. Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

Charging Guide

12 VOLT BATTERY RECOMMENDED RATE[1] AND TIME FOR FULLY DISCHARGED CONDITION

Twenty Hour Rating	5 Amps	10 Amps	20 Amps	30 Amps	40 Amps	50 Amps
50 Ampere-Hours or less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/2 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

[1] Initial rate for constant voltage taper rate charger.

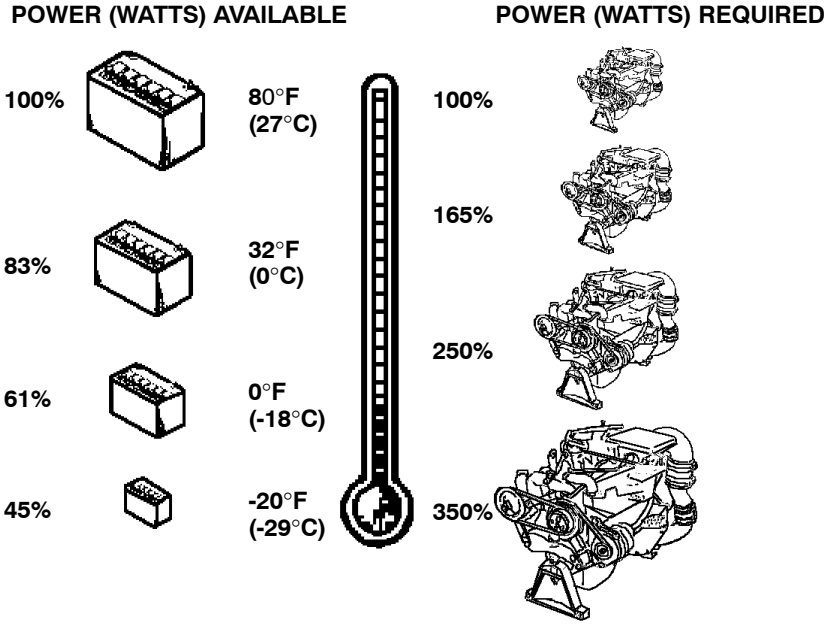
To avoid damage, charging rate must be reduced or temporarily halted, if:

1. Electrolyte temperature exceeds 125° F (52° C).
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

How Temperature Affects Battery Power

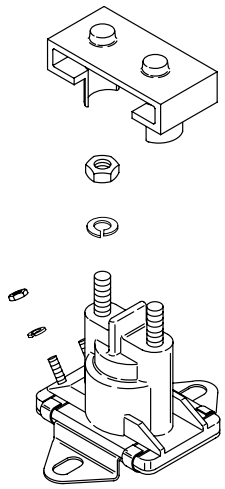


Standard Starter Slave Solenoid

Identification

There are two types of slave solenoids (“standard” or “switch”) used on Mercury MerCruiser engines. These engines use a standard type solenoid; **do not substitute a switch type solenoid.** The other engines use a slave solenoid to energize the starter motor solenoid. Some model engines use the small terminal on the “switch type” solenoid for ignition by-pass during the starting of the engine. Because of this, be sure to use correct type of slave solenoid for replacement.

Standard Type Slave Solenoid



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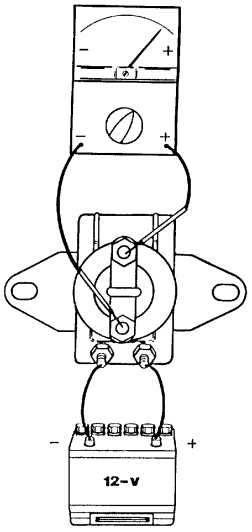
Testing / Replacement

1. Using continuity meter, connect test leads and connect 12 volt battery with jumper leads as shown.



72630

2. If no meter movement is present, replace solenoid.

Installation

IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb-ft (41 Nm).
2. Connect YELLOW/RED wire to terminal S of solenoid.
3. Connect ORANGE wire, RED wire, and battery cable to large terminal of solenoid.
4. Tighten fasteners securely.
5. Coat terminals with Quicksilver Liquid Neoprene.
6. Install battery cable boot, if equipped.
7. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

Permanent Magnet - Gear Reduction (PG260F1) Starter Motor

Starter Specifications

PG260F1 Starter Motor						
MerCruiser Part Number				50-807904		
Delco Identification Number	Engine Rotation	Volts	No Load Test			
			Min. Amps	Max. Amp	Min. rpm	Max. rpm
9000839 - 9000840	LH	11.5	40	90	3200	4800
Brush Spring Length				Length New - 0.36 - 0.42 in. (9.2 - 10.7 mm) Length Used - 0.18 - 0.23 in. (4.62 - 5.98 mm)		
Pinion Clearance				0.009 - 0.160 in. (0.23-4.06 mm)		
Bearing Depth (Gear)				Flush - Inside		
Bearing Depth (Housing)				.009-.017 (0.4mm) Maximum		

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Starter Mounting Bolts		30	41
All Other Fasteners		Tighten Securely	

Lubricants / Sealants

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Liquid Neoprene	92-25711--3
SAE 10W Oil	Obtain Locally

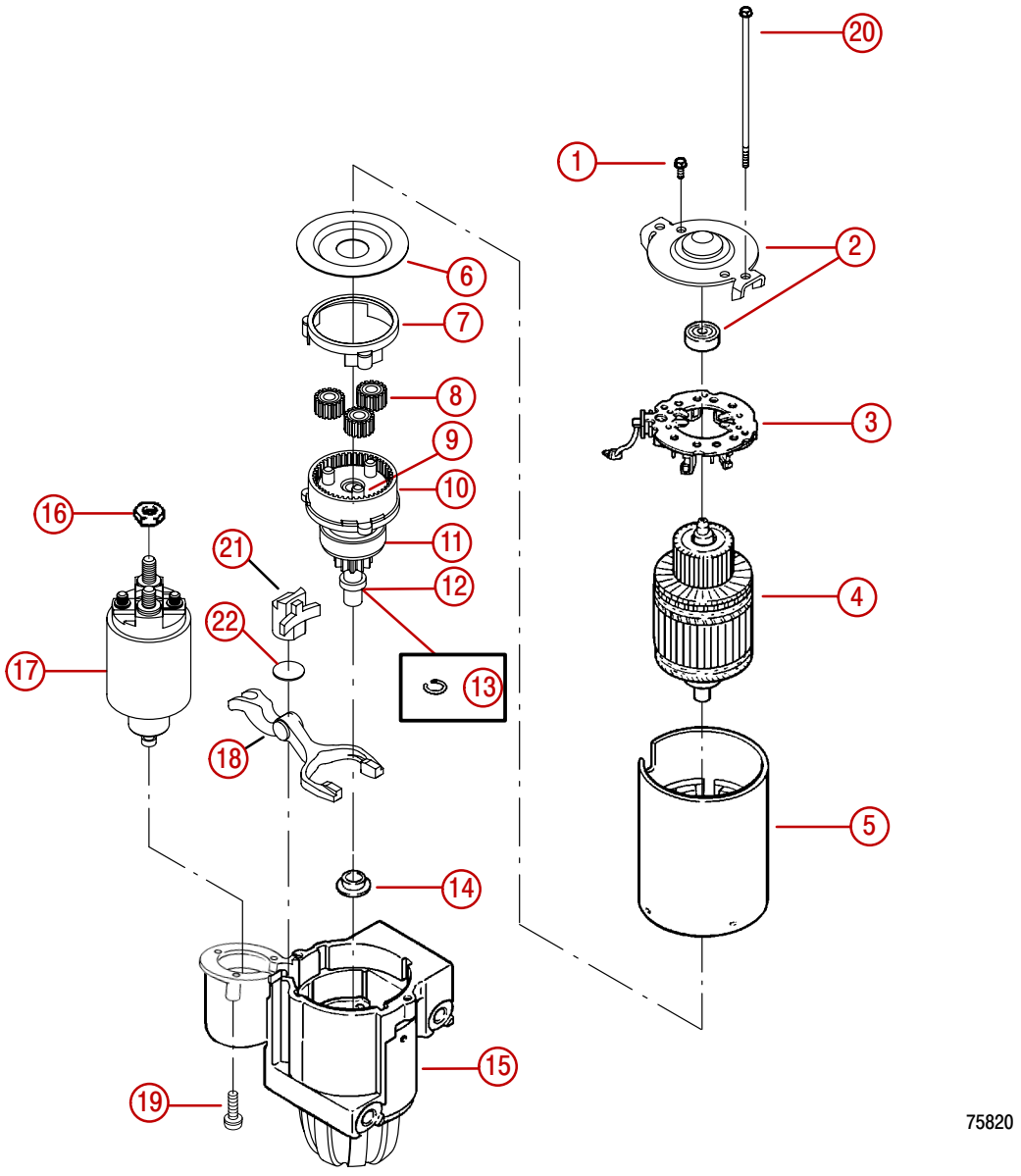
Description

The Permanent Magnet Gear Reduction starter motors feature small permanent magnets mounted inside the field frame (NOTE: The actual configuration of these magnets differs between the models; the field frames with permanent magnets are not interchangeable. Otherwise, the units are similar.) These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4 to 1, through planetary gears results in armature speeds in the 7000 rpm range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

⚠ CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

PG260F1 Exploded View



1 - Screw (2)
2 - End Frame and Bearing
3 - Brush With Holder
4 - Armature
5 - Field Frame (With Permanent Magnets)
6 - Washer
7 - Shield
8 - Planetary Gears
9 - Shaft
10 - Gear
11 - Drive
12 - Collar
13 - Retaining Ring
14 - Trust Collar
15 - Drive Housing
16 - Nut
17 - Solenoid
18 - Solenoid Drive Arm
19 - Screw (3)
20 - Long Screw (2)
21 - Rubber Grommet
22 - Metal Disc

Solenoid Switch

The solenoid switch can be removed and replaced if defective.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Motor

Removal

⚠ WARNING

Disconnect battery cables at battery before removing starter.

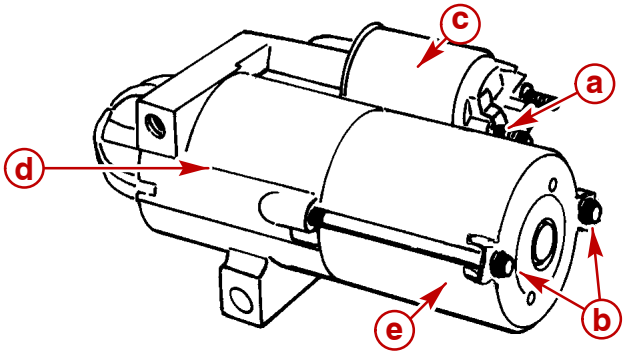
1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.

IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Disassembly

1. Remove brush lead from solenoid and long screws from end frame.

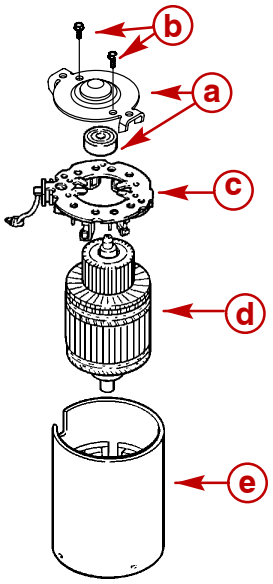


75820

a - Brush Lead
b - Screws
c - Solenoid Switch
d - Drive Housing
e - Field Frame

2. Remove armature and field frame from drive housing.

NOTE: *Permanent magnets inside field frame will be holding armature in place.*



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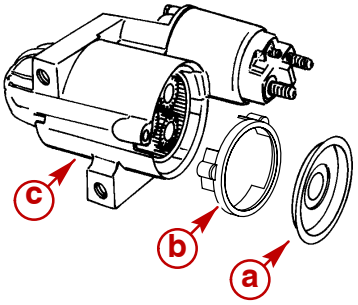
a - End Frame and Bearing
b - Screws (2)
c - Brush Holder
d - Armature
e - Field Frame

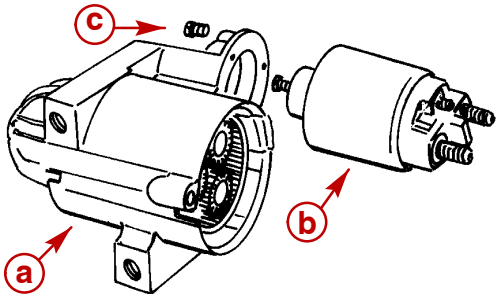
3. Remove shield and washer from drive housing.



74038

a - Shield
b - Washer
c - Drive Housing

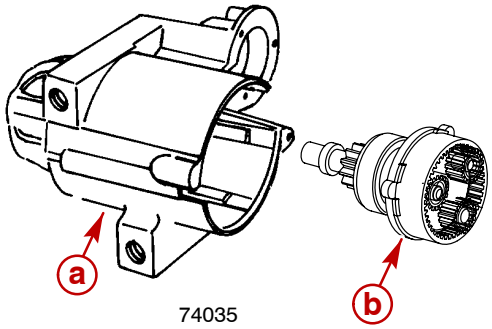
4. Remove the three screws retaining the solenoid.
5. Remove solenoid from drive housing.



74036

a - Drive Housing
b - Solenoid
c - Screws (3)

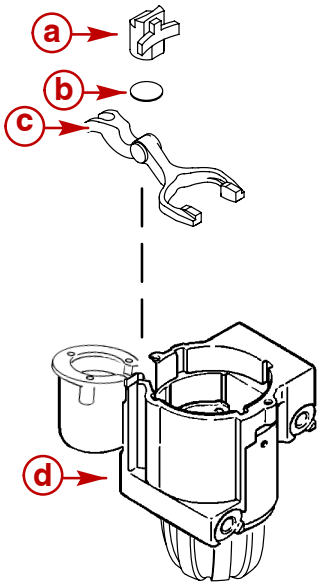
6. Remove drive and associated parts from drive housing.



74035 75821

a - Drive Housing
b - Drive

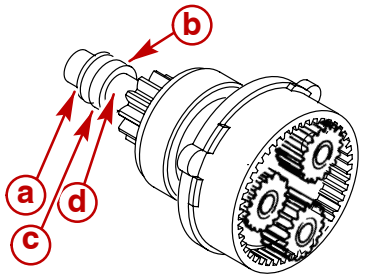
7. Remove solenoid arm, metal disc and rubber grommet from the drive housing.



75821

a - Rubber Grommet
b - Metal Disc
c - Solenoid Arm
d - Drive Housing

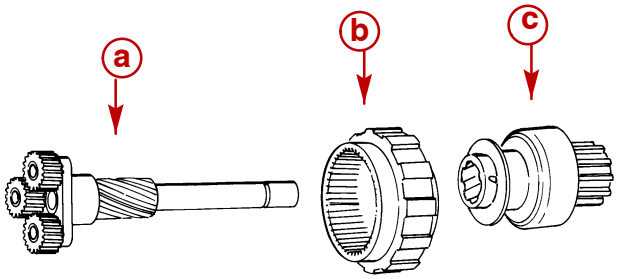
8. Remove thrust collar, retaining ring and collar from planetary shaft with drive.



75821

a - Thrust Collar
b - Retaining Ring (Inside Collar)
c - Collar
d - Planetary Shaft and Drive

9. Remove drive and gear from planetary shaft.



74087

a - Gear
b - Shaft Assembly
c - Drive

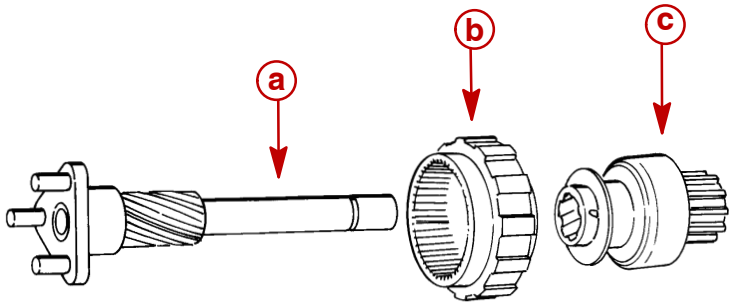
Cleaning and Inspection

IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction.
2. Check pinion teeth.
3. Check spring for tension and drive collar for wear. Replace if necessary.
4. Check that brush holders are not damaged or bent and hold brushes against commutator.
5. Inspect all roller bearing surfaces for wear. Check that bearings roll freely. If any roughness is felt, replace bearing.
6. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Reassembly

1. Install gear and drive over planetary shaft.

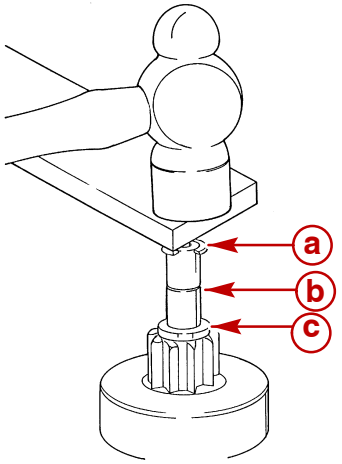


74087

Typical

a - Planetary Shaft
b - Gear
c - Drive

2. Assemble drive on shaft assembly as follows:
   a. Lubricate drive end of shaft assembly with SAE 10W oil.
   b. Place gear over shaft.
   c. Slide drive assembly onto shaft with pinion facing outward.
   d. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   e. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.

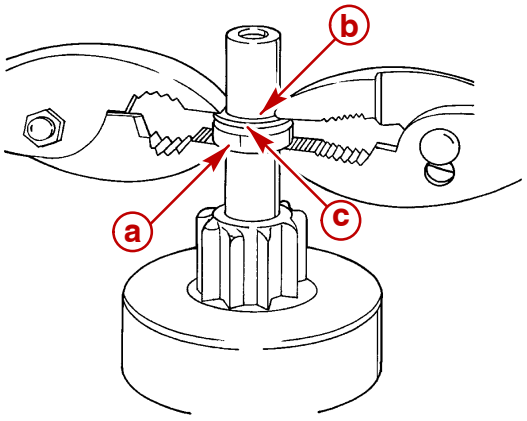


72073

a - Snap Ring
b - Groove
c - Retainer

f. Assemble thrust collar on shaft with shoulder next to snap ring.

g. Position retainer and thrust collar next to snap ring. Then, using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.

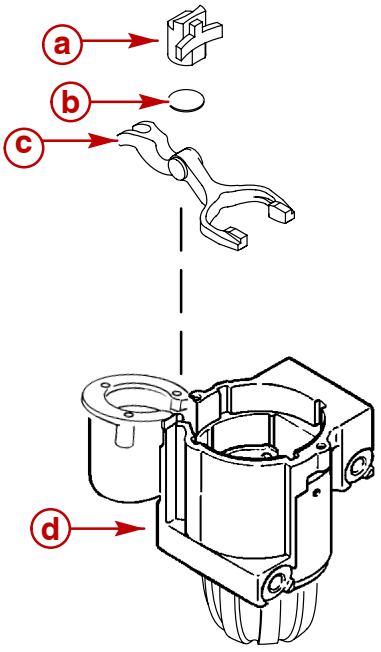


72074

a - Retainer
b - Thrust Collar
c - Snap Ring

3. Install the planetary gears on planetary gear shaft assembly.
4. Install solenoid arm, metal disc and rubber grommet in the drive housing.

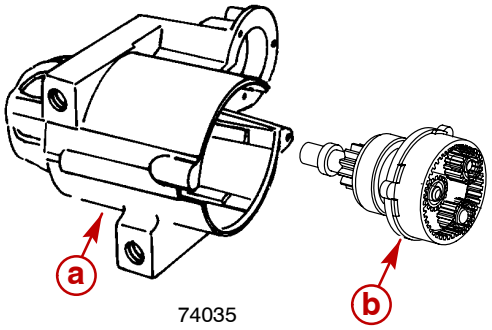
NOTE: *Solenoid arm is designed to fit only one way. Do not use force.*



75821

a - Rubber Grommet
b - Metal Disc
c - Solenoid Arm
d - Drive Housing

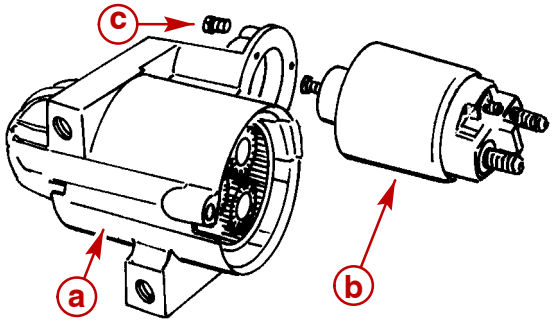
5. Install drive and associated parts in drive housing.



74035 75821

a - Drive Housing
b - Drive

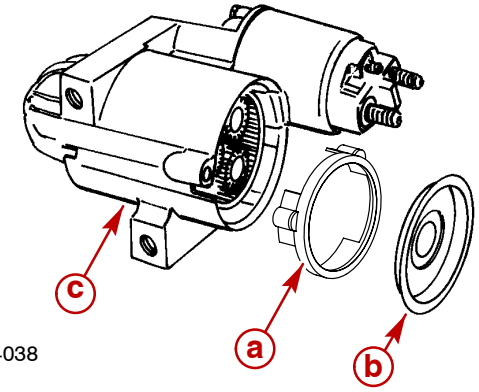
6. Attach solenoid arm to solenoid. Place solenoid in drive housing and tighten screws.



74036

a - Drive Housing
b - Solenoid
c - Screw (3)

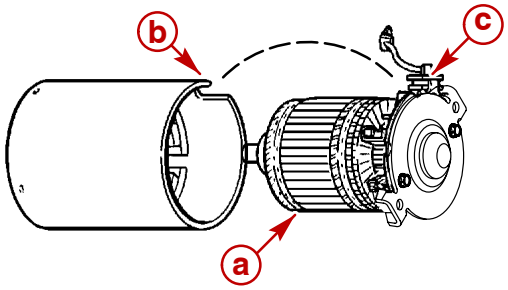
7. Install washer and shield in drive housing.



74038 75821

a - Washer
b - Shield
c - Drive Housing

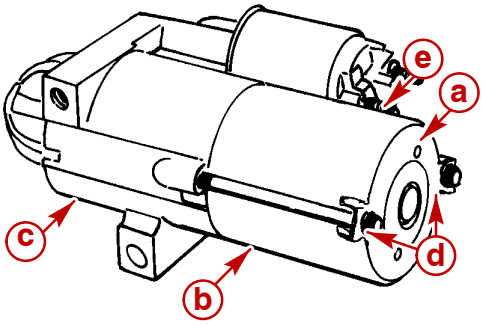
8. Install field frame over armature. Align slot in field frame with rubber grommet.



75821

a - Armature
b - Field Frame Slot
c - Rubber Grommet

9. Install field frame and end frame in drive housing.
10. Install long screws and brush lead. Tighten fasteners securely.



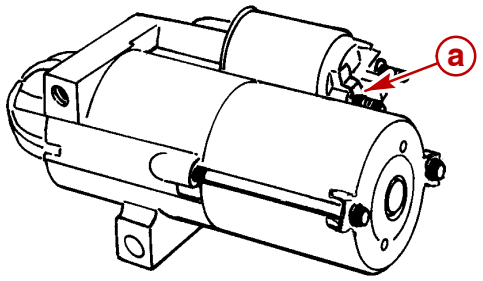
75821

a - End Frame
b - Field Frame
c - Drive Housing
d - Long Screws
e - Brush Lead

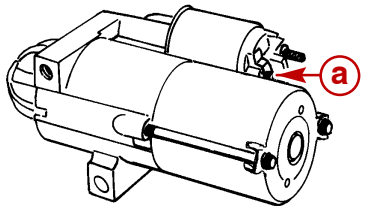
Checking Pinion Clearance

Pinion clearance must be checked after reassembly of starter motor.

1. Disconnect brush lead from solenoid motor and insulate it carefully.



74041



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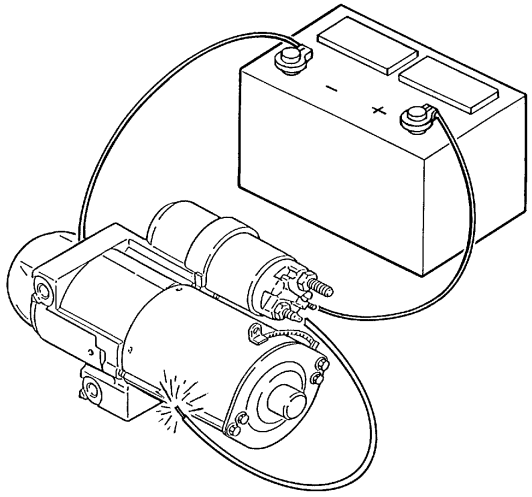
a - Brush Lead

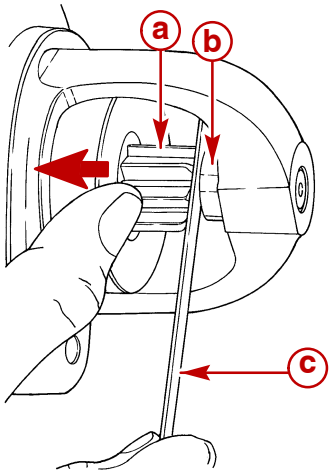
2. Connect 12 volt battery positive (+) lead to battery terminal and negative (–) lead to frame.
3. Momentarily touch a jumper lead from battery terminal to switch terminal. This shifts pinion into cranking position where it will remain until battery is disconnected.



72629

4. Push pinion back toward commutator end to eliminate slack.
5. Measure distance between pinion and pinion retainer.

6. If clearance is not within limits of .010-.160 in. (0.25-4.00 mm), it may indicate excessive wear of solenoid linkage, shift lever yoke or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.



72077

a - Pinion
b - Retainer
c - Feeler Gauge

Installation

IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb-ft (41 Nm).
2. Connect YEL/RED wire to terminal S of solenoid. Connect ORG wire, RED wire, and battery cable to large terminal of solenoid. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if equipped.
3. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

Delco PG260 Starter

PG260 Specifications

Delco I.D. Number	Engine Rotation	No Load Test					Brush Spring Tension Oz. (Grams)
		Volts	Min. Amps	Max. Amps	Min. rpm	Max. rpm	
9000820	LH	10.6	60	95	2750	3250	83-104 oz. (2352-2948)
Pinion Clearance		.101-.160 (.025-4.06mm)					
Bearing Depth (Gear)		.011-.014 (0.28-.038mm) Maximum					
Bearing Depth (Housing)		.009-.017 (0.4mm) Maximum					

Torque Specification

Fastener Location	lb-in.	lb-ft	Nm
Starter Mounting Bolts		30	41
Fastener Not Listed		Tighten Securely	

NOTE: *The PG260 starter cannot be rebuilt. The only replacement components available are the solenoid and drive housing.*

Lubricants / Sealants

Description	Part Number
Quicksilver 2 4 C Marine Lubricant With Teflon	92-825407A3
Quicksilver Liquid Neoprene	92-25711--3
SAE 10W Oil	Obtain Locally

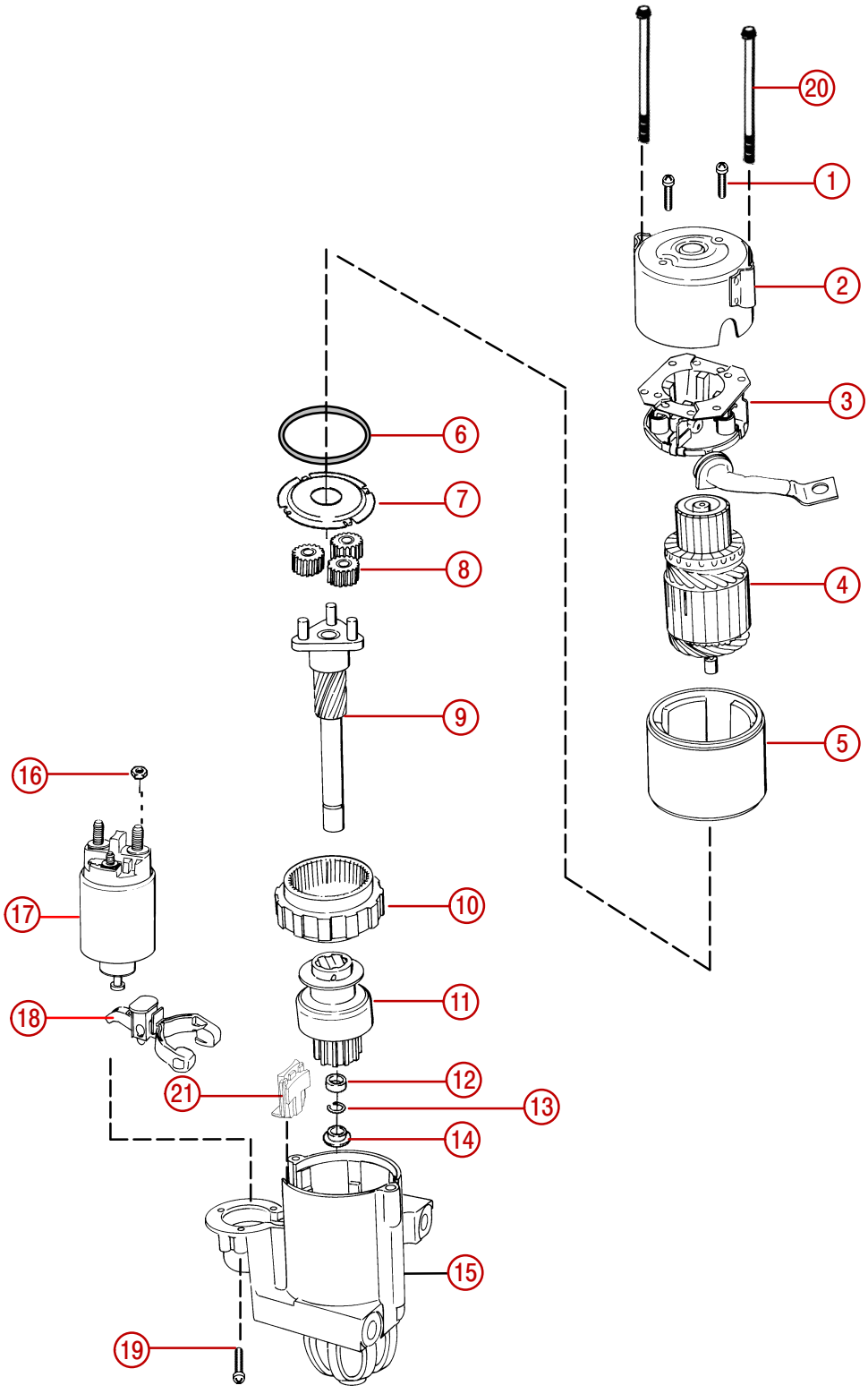
Description

The Delco PG260 starter motor features small permanent magnets mounted inside the field frame. These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4 to 1, through planetary gears results in armature speeds in the 7000 rpm range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

⚠ CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

PG260 Exploded View



1 - Screw (2)
2 - End Cap
3 - Brushes with Holder
4 - Armature
5 - Field Frame (with Permanent Magnets)
6 - Washer
7 - Shield
8 - Planetary Gears
9 - Shaft
10 - Gear
11 - Drive
12 - Collar
13 - Retaining Ring
14 - Thrust Collar
15 - Drive Housing
16 - Nut
17 - Solenoid
18 - Solenoid Drive Arm
19 - Screw (3)
20 - Thru Bolt (2)
21 - Rubber Grommet

Solenoid Switch

The solenoid switch plunger, return spring and shift lever are completely sealed and permanently mounted in the drive housing. If solenoid is defective, entire drive housing must be replaced.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required.

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Motor

Removal

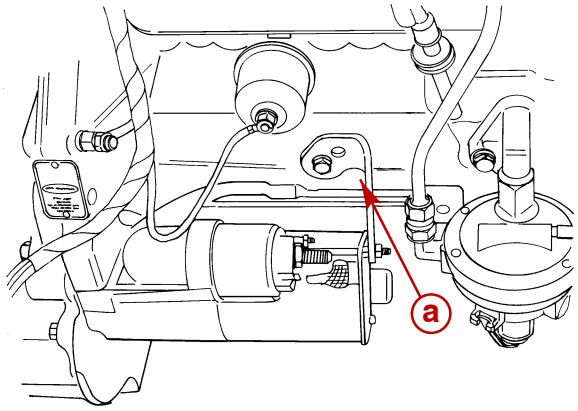
⚠ WARNING

Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.

IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

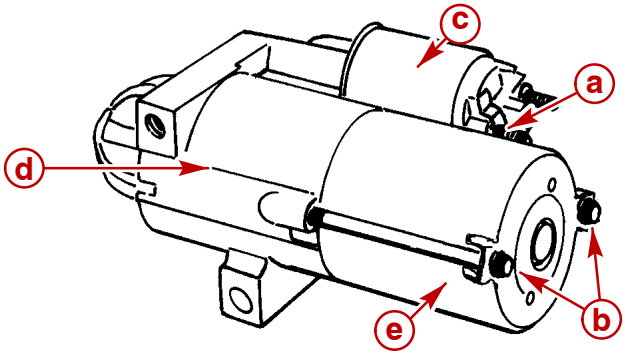


74523

a - Starter Bracket (If Equipped)

Disassembly

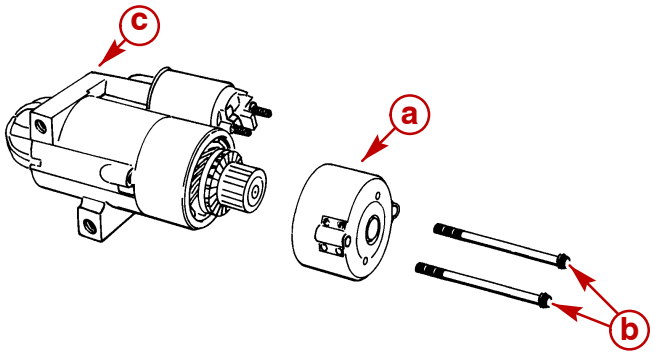
1. Remove brush lead from solenoid and screws from end frame.



75820

a - Brush Lead
b - Screws
c - Solenoid Switch
d - Drive Housing
e - Field Frame

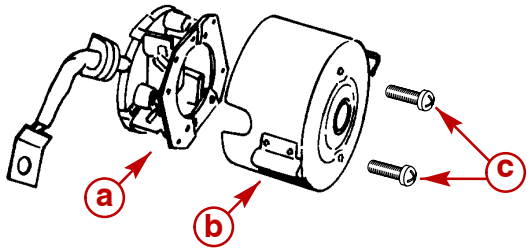
2. Remove through bolts and separate end frame from field frame and end cap.



74040

a - End Cap
b - Through Bolt
c - Drive Housing

3. Remove brush holder from end cap.

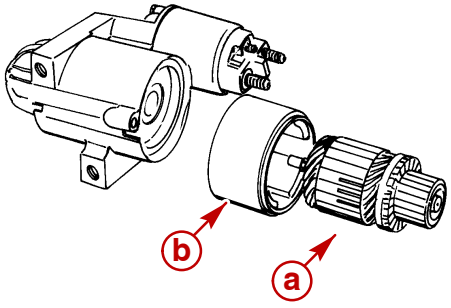


74037

a - Brush Holder
b - End Cap
c - Screws (2)

4. Remove armature and field frame from drive housing.
5. Pull armature out of field frame.

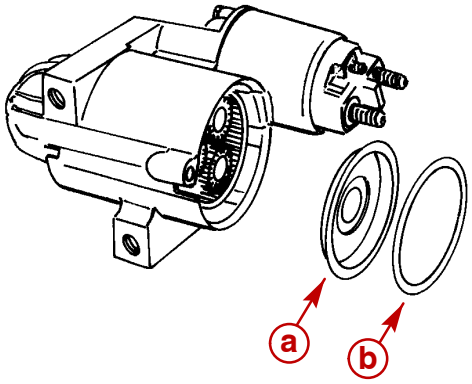
NOTE: *Permanent magnets inside field frame will be holding armature in place.*



74086

a - Armature
b - Field Frame

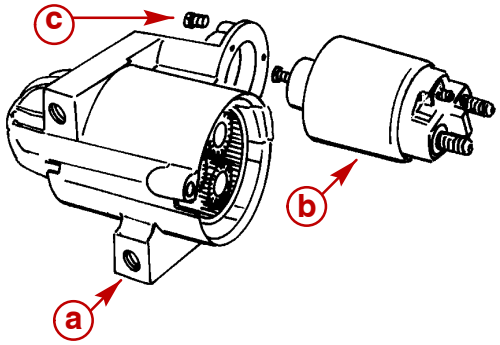
6. Remove shield and washer.



74038

a - Shield
b - Washer

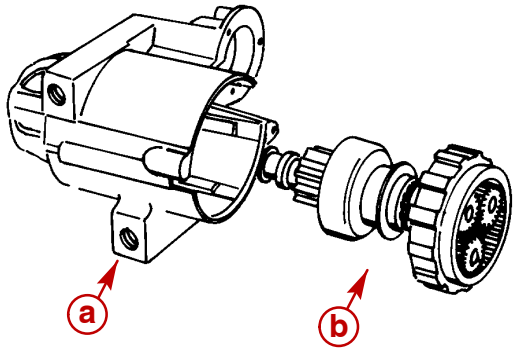
7. Remove the three screws retaining the solenoid.
8. Remove solenoid from drive housing.



74036

a - Drive Housing
b - Solenoid
c - Screws (3)

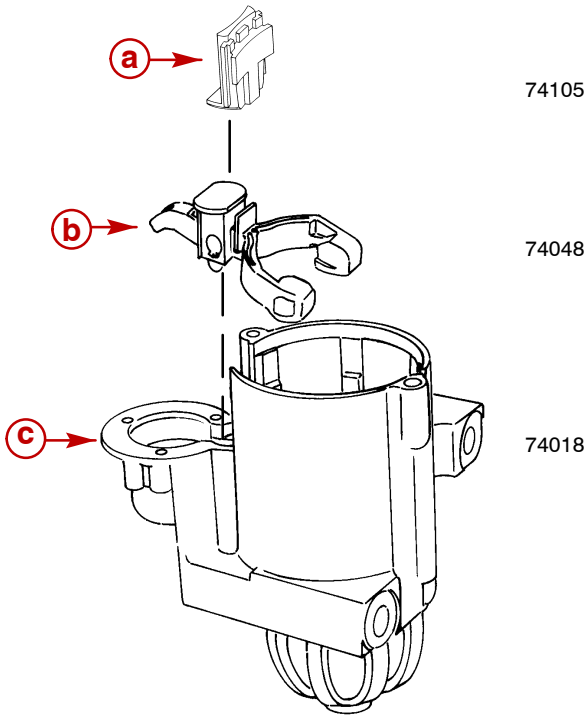
9. Remove drive and associated parts from drive housing.



74035

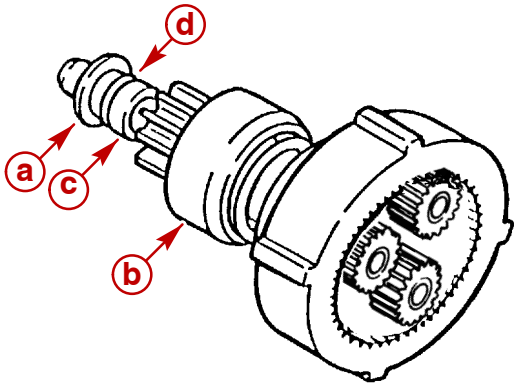
a - Drive Housing
b - Drive

10. Remove solenoid arm and rubber grommet from the drive housing.



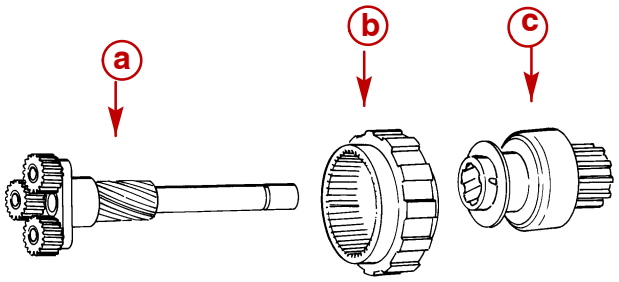
a - Rubber Grommet
b - Solenoid
c - Drive Housing

11. Remove thrust collar, retaining ring and collar from planetary shaft.



a - Thrust Collar
b - Retaining Ring
c - Collar
d - Drive

12. Remove drive and gear from planetary shaft.



a - Gear
b - Shaft Assembly
c - Drive

Cleaning and Inspection

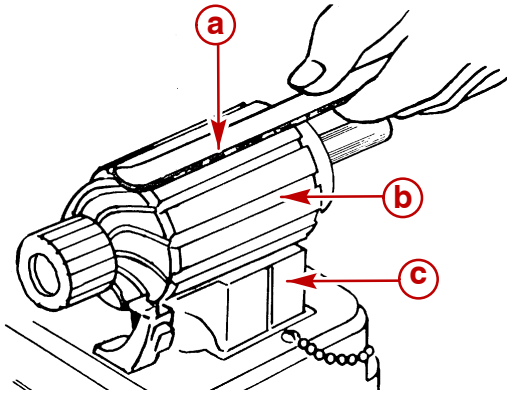
IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction.
2. Check pinion teeth.
3. Check spring for tension and drive collar for wear. Replace if necessary.
4. Check that brush holders are not damaged or bent and hold brushes against commutator. Check brushes for wear.
5. Inspect armature commutator. If badly grooved or out-of-round, turn down and undercut commutator.
6. Inspect all roller bearing surfaces for wear. Check that bearings roll freely. If any roughness is felt, replace bearings.
7. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.

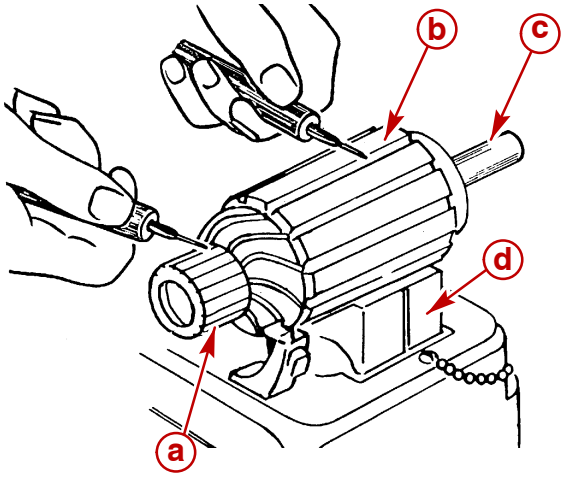


01440

a - Hacksaw Blade
b - Armature Cover
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves, armature is grounded and must be replaced.



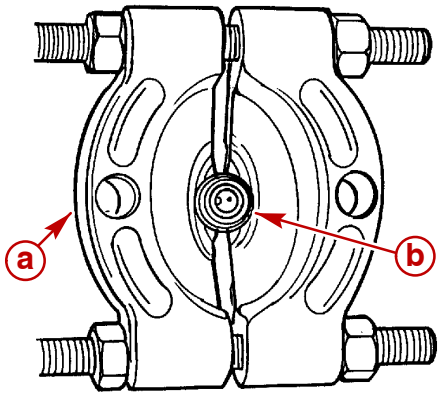
01441

a - Commutator
b - Armature Core
c - Shaft
d - Growler

Armature Bearing (Commutator End)

REMOVAL

Use a universal puller plate, as shown, to remove bearing.



72068

a - Universal Puller Plate
b - Bearing

INSTALLATION

IMPORTANT: Brush holder must be installed on armature before installing armature bearing.

Using the correct size driver, press on inner bearing race until it contacts shoulder of armature shaft.

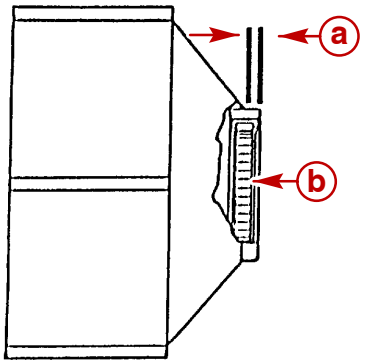
Gear Bearing

REMOVAL

Using the correct size driver, press bearing out of gear.

INSTALLATION

1. Using the correct size driver, press bearing into gear, from direction shown, to depth specified.



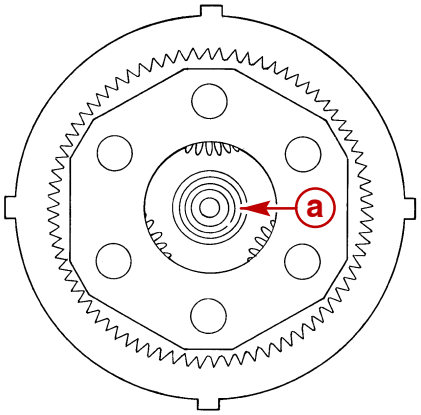
72625

a - Depth - .011-.014 in. (0.28-0.38 mm)
b - Installation Direction

2. Lubricate bearing and gear teeth with a small amount of Quicksilver 2-4-C Marine Lubricant with Teflon.

Shaft Assembly Bearing

IMPORTANT: Roller bearing is not replaceable. If bearing is defective, replace entire shaft assembly. Apply Quicksilver 2-4-C Marine Lubricant with Teflon to bearing before starter reassembly.



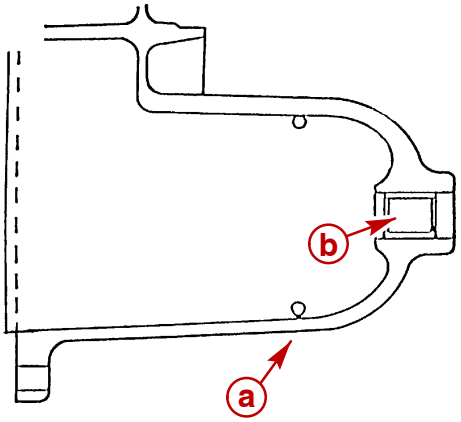
72070

a - Roller Bearing

Drive End Housing Bearing

REMOVAL

1. Using the correct size driver, press bearing out of housing.

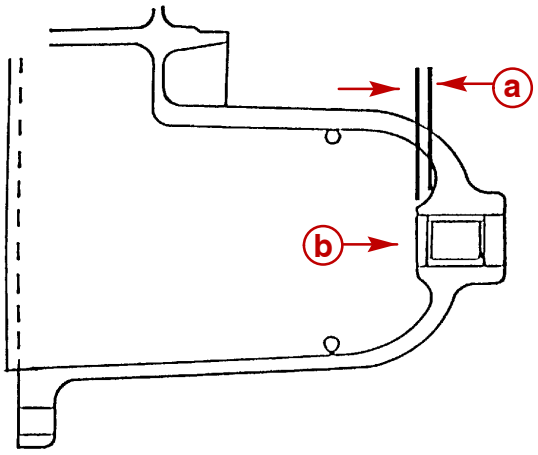


72626

a - Drive End Housing
b - Bearing

INSTALLATION

1. Using the correct size driver, press bearing into housing, from direction shown, to depth specified.



72626

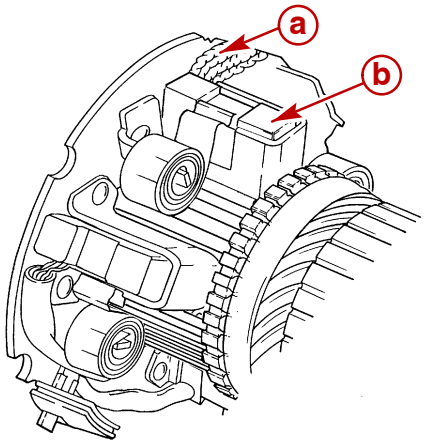
a - Depth - .009-.017 in. (0.25-0.45 mm)
b - Installation Direction

2. Lubricate bearing with a small amount of Quicksilver 2-4-C Marine Lubricant with Teflon.

Brushes and Brush Holder

INSPECTION

1. Replace brushes and holder when brush leads are touching guide.
2. Make sure brushes move freely in guides.



72069

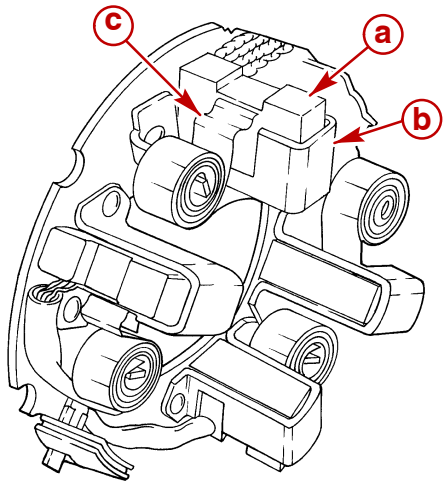
a - Brush Leads
b - Guide

REMOVAL

1. Remove armature bearing.
2. Remove brush holder.

INSTALLATION

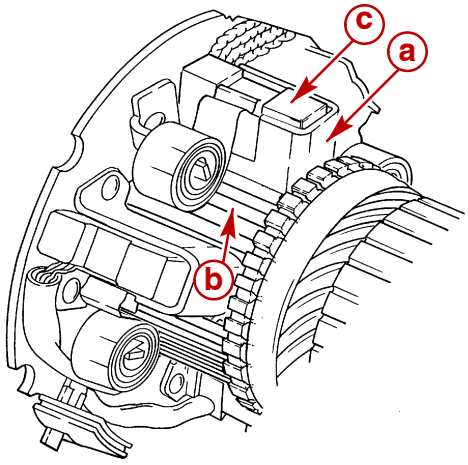
1. Push each brush up into its guide to allow spring to hold it in place.



72072

a - Brush
b - Guide
c - Brush Spring

2. Place brush holder on armature and push brushes down against commutator.



72069

a - Brush Holder
b - Commutator
c - Brush

3. Install armature bearing.

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ELECTRICAL SYSTEMS

Section 4B - Thunderbolt V Ignition System

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4 B

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser power package are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided.

General Precautions

⚠ CAUTION

Avoid personal injury and/or property damage. Listed below are some of the precautions, along with others listed throughout this manual, that you should observe to help ensure an accident-free maintenance experience:

- **Always disconnect battery cables from battery BEFORE working on electrical system to prevent injury to yourself or damage to electrical system.**
- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet and clothing clear of moving parts.**
- **DO NOT touch or disconnect any ignition system parts while engine is running.**
- **DO NOT reverse battery cable connections. System is negative (–) ground.**
- **DO NOT disconnect battery cables while engine is running.**
- **When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.**
- **Replace a component if there is any doubt as to the condition of the component.**

⚠ WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet and clothing clear of moving parts.**
- **DO NOT touch or disconnect any ignition system parts while engine is running.**
- **DO NOT reverse battery cable connections. System is negative (–) ground.**
- **DO NOT disconnect battery cables while engine is running.**

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EFI System Maintenance Precautions

⚠ WARNING

Avoid Injury or Electrical System Damage: Always disconnect battery cables from battery before working around electrical system components. See CAUTION following:

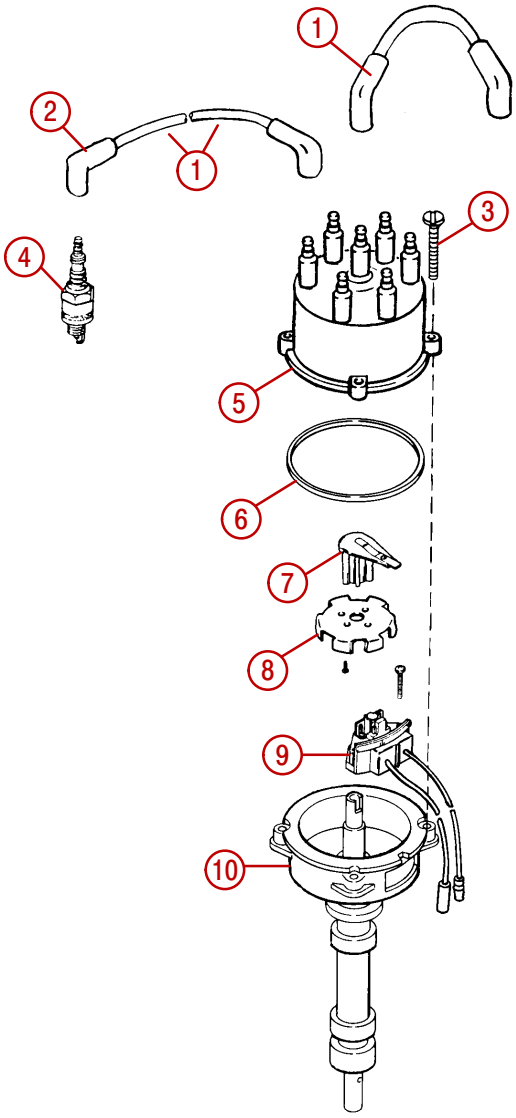
⚠ CAUTION

Avoid damage to the EFI electrical system components: Refer to the following precautions when working on or around the EFI electrical harness, or when adding other electrical accessories:

- **DO NOT tap accessories into engine harness.**
- **DO NOT puncture wires for testing (Probing).**
- **DO NOT reverse battery leads.**
- **DO NOT splice wires into harness.**
- **DO NOT attempt diagnostics without proper, approved Service Tools.**

Thunderbolt V Ignition System

Identification



75856

1 - Cable Kit - Ignition (Spark Plug and Coil)
2 - Boot
3 - Screw
4 - Spark Plug
5 - Cap
6 - Gasket
7 - Rotor
8 - Sensor Wheel
9 - Sensor Assembly
10 - Housing

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Timing and Idle Adjustment Procedures

Setting Base Ignition Timing

1. Connect timing light (91-99379 or similar) to No. 1 spark plug wire. Connect power supply leads, if applicable, on light to 12 volt battery.
2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the Base Timing Mode.

NOTE: *Before starting engine make sure the timing tab and marks on damper are clean. Chalk or white paint on timing marks may help visibility.*

4. Start engine and run at normal idle speed. Allow engine to reach normal operating temperature.
5. Aim timing light at timing tab, located on the timing gear cover and crankshaft torsional damper.
6. If adjustment is required, adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on damper or pulley lines up with the mark on tab specified in “Specifications.” Tighten clamp and recheck location of timing mark.
7. Make sure that the distributor has been tightened. Remove the jumper wire from the timing terminal.
8. Remove jumper wire between the timing lead (PUR/WHT wire) and ground (–).

IMPORTANT: Be sure to disconnect the jumper wire from between the ignition system timing lead and ground (–) before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the Base Timing Mode. This means that the additional timing advance features would not function.

9. Stop engine and remove timing light.

Adjusting Idle Mixture

The procedure for adjusting carburetor idle mixture can be found in the appropriate engine service manual. This procedure also requires that the ignition module be locked in the “Base Timing Mode.”

IMPORTANT: In order to properly set idle mixture, the ignition module MUST BE locked in the Base Timing Mode. This is necessary because of the Idle Speed Control feature that exists in the ignition module. See information on the previous pages about this feature.

To adjust the idle mixture screw correctly, the throttle plates must be nearly closed. Please do the following:

1. Disconnect throttle cable.
2. Set idle speed (rpm) screw so engine idles at 550-600 rpm in neutral gear.
3. Adjust idle mixture screw.
4. Reset the idle speed screw until engine idles at its recommended rpm.
5. Adjust and connect throttle cable.

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Spark Plugs

Specifications

Model	4.3L / 4.3LH	4.3L EFI
Spark Plug Gap	.045 in. (1.1 mm)	
Spark Plug Type	AC-MR43LTS NGK-BPR6EFS Champion RS12YC	

Removal

1. Disconnect spark plug wires (high tension leads) from spark plugs.

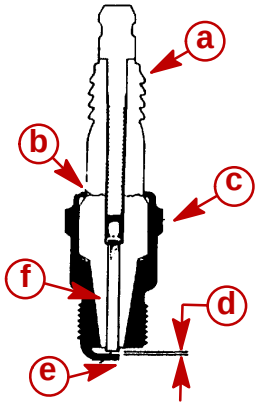
NOTE: *Use care when removing spark plug wires and boots from spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire end.*

2. Remove spark plugs.

NOTE: *A "thin-walled" spark plug socket may be required.*

Inspection

1. Inspect each spark plug for manufacturer and spark plug number. All plugs must be from the same manufacturer and have the same spark plug number. Refer to SECTION 1B. - "Specifications" for spark plug numbers.
2. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.



72734

a - Porcelain Insulator
b - Insulator - Cracks Often Occur at This Point
c - Shell
d - Proper Gap
e - Side Electrode
f - Center Electrode (When Adjusting Gap - DO NOT Bend)

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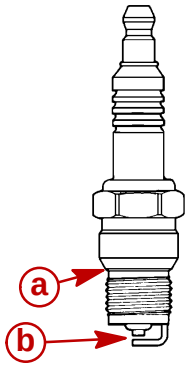
Replacing

1. Clean the plug seating area on the cylinder heads.
2. Adjust spark plug gap with a round feeler gauge. Bend side electrode to adjust gap. Refer to SECTION 1B – “Specifications” for correct spark plug gap.



75084

a - Seating Area
b - Gap

IMPORTANT: It is recommended that spark plugs be torqued to the amount specified. In the absence of a torque wrench or access problems to the plugs, the spark plugs should be hand tightened until the plug seats on the cylinder head. Then, securely tighten with appropriate wrench and socket.

3. Install spark plugs and torque to specifications. Refer to “Torque Specifications” in this section.
4. Install spark plug wires in proper order. Refer to “Engine Rotation and Firing Order” and/or “Spark Plug Wires,” following.

Description

The Thunderbolt V ignition system has several spark control features that will be described following:

- Idle Speed Spark Control
- Acceleration Spark Advance
- Mean-Best-Timing Spark Advance
- Over-Speed Control (Rev-Limiter)
- Knock Retard Spark Control

Idle Speed Spark Control

The ignition module will control ignition timing to maintain a calibrated idle speed. This is accomplished by making small spark advance adjustments. This feature is only active within a certain rpm range. This range may be slightly different from one engine model to another. The approximate range is 400-700 rpm.

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Acceleration Spark Advance

This feature is active during acceleration only. When accelerating, the ignition module may add more spark advance to the “Base Spark Timing Curve”. The amount of spark advance added, is totally dependant on how fast rpm increases (how fast the throttle is moved). This feature is also active within a certain rpm range. This range may be slightly different from one engine model to another. The approximate rpm range for this feature is 1200-4000 rpm. Within this range, the module can add approximately 10 degrees of spark advance to the base spark timing curve.

Mean-Best-Timing (MBT) Spark Advance

During light load cruising, the ignition module searches for the optimal ignition timing. This is also accomplished by small changes to the spark advance. At a given rpm, the module will try to add a small amount of advance and wait to see if there is an rpm change. If rpm increases, it will try to increase timing more. The module will continue to advance timing until it no longer gets an increase in rpm. Conversely, if it senses an rpm drop, it will start to retard some of the spark timing. The approximate rpm range for this feature is 1200-4000 rpm. Within this range, the ignition module can add approximately 10-15 degrees of spark advance to the base spark timing curve.

NOTE: *The Audio Warning System is also connected into the ignition module circuit. If the audio warning system becomes activated by the closing of one of the audio warning system switches, the MBT feature is deactivated.*

Over-Speed Control

The ignition module will prevent the engine speed from exceeding a preset limit by stopping the spark. This feature has an rpm range that varies from model to model. The over-speed limit for a particular engine is set slightly higher than the top end of the rpm range for that model. For example, if the recommended range is 4600-5000 rpm, the over-speed limit would be set at 5100 rpm. When rpm reaches this limit, spark is turned-off until engine rpm drops down to a “Reset rpm”, which would be approximately 4750 rpm for this example. At this point, spark comes back on.

Knock Retard Spark Control

The knock control feature helps provide protection from harmful detonation. Knock control is handled by the Knock Control Module. This module receives a signal from a sensor that is mounted on the engine block. The knock control module works in conjunction with the ignition module to retard the timing if spark knock is present.

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Spark Plug Wires

1. Inspect spark plugs for damage.
2. Check spark plugs for continuity using Multi-Meter / DVA (91-99750) or similar.
3. Replace any wires that are cracked, cut, or have damaged spark plug boots.
4. Replace any wires that do not show continuity from end to end.
5. Reinstall wires in proper order. Observe the following:

IMPORTANT: Proper positioning in spark plug wire supports is important to prevent cross-firing.

IMPORTANT: Before installing coil wire to coil, apply approximately 1/2 oz of insulating compound around top of coil lead tower. Force nipple into coil and wipe off excess. Make sure boot does not hydraulically remove from the distributor cap terminal.

Adjusting Engine Idle Speed

This procedure should be done with boat in the water, drive unit in neutral and engine at normal operating temperature. Refer to the SECTION 1B - “Specifications” for the correct idle speed.

1. Disconnect the throttle cable from carburetor.

IMPORTANT: In order to properly set idle speed, the ignition module MUST BE locked in the Base Timing Mode. This is necessary because of the Idle Speed Control feature that exists in the ignition module. See information on the previous pages about this feature.

2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead 13 (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the Base Timing Mode.
4. Start engine and allow it to reach normal operating temperature.
5. Adjust idle speed to recommended rpm.
6. Stop engine. Readjust cable barrel and reinstall the throttle.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the Base Timing Mode. This means that the additional timing advance features would not be functioning.

7. Remove the jumper wire from the timing terminal.

Circuit Description

Refer to the circuit wiring diagram on the following page for reference to this circuit description.

Ignition Control Module

- The ignition module receives its power (+) thru the PUR wire “9”.
- Ignition module ground (–) is accomplished thru the BLK wire “10”.
- There is also a Case Ground (–) wire “12” that is connected to one of the ignition module attaching screws.
- The 12 volt signal from the ignition module to the distributor is carried through the WHT/RED wire “8”, to the distributor sensor and back to the ignition module through the WHT/GRN wire “7”.
- The tachometer signal is carried to the instrument panel thru the GRY wire “11”.
- The PUR/WHT wire “3” carries the signal from the knock control module to the ignition control module.
- There are two BLK wires “5” that have bullet connectors. This circuit is reserved for future options. On current models, the two BLK wires must be connected for the system to function properly.
- The TAN/BLU wire “6” carries a signal from the audio warning circuit to the ignition module.

Knock Control Module

- The knock control module receives it’s power (+) from the PUR wire “4”.
- Knock module ground (–) is accomplished thru the BLK wire “2”.
- The PUR/WHT wire “3” carries the signal from the knock control module to the ignition control module.
- The BLU wire “1” carries the signal from the knock sensor to the knock module.

Ignition Control System Timing Lead

The ignition control system has a lead with bullet connector “11” that is connected into the PUR/WHT wire “3”. This lead is used for performing the following tests and procedures:

- Setting Base Ignition Timing
- Setting Engine Idle Speed
- Setting Idle Mixture
- Testing Knock Control Circuit

This lead, when connected to an engine ground (–), locks the ignition control module into the Base Timing mode.

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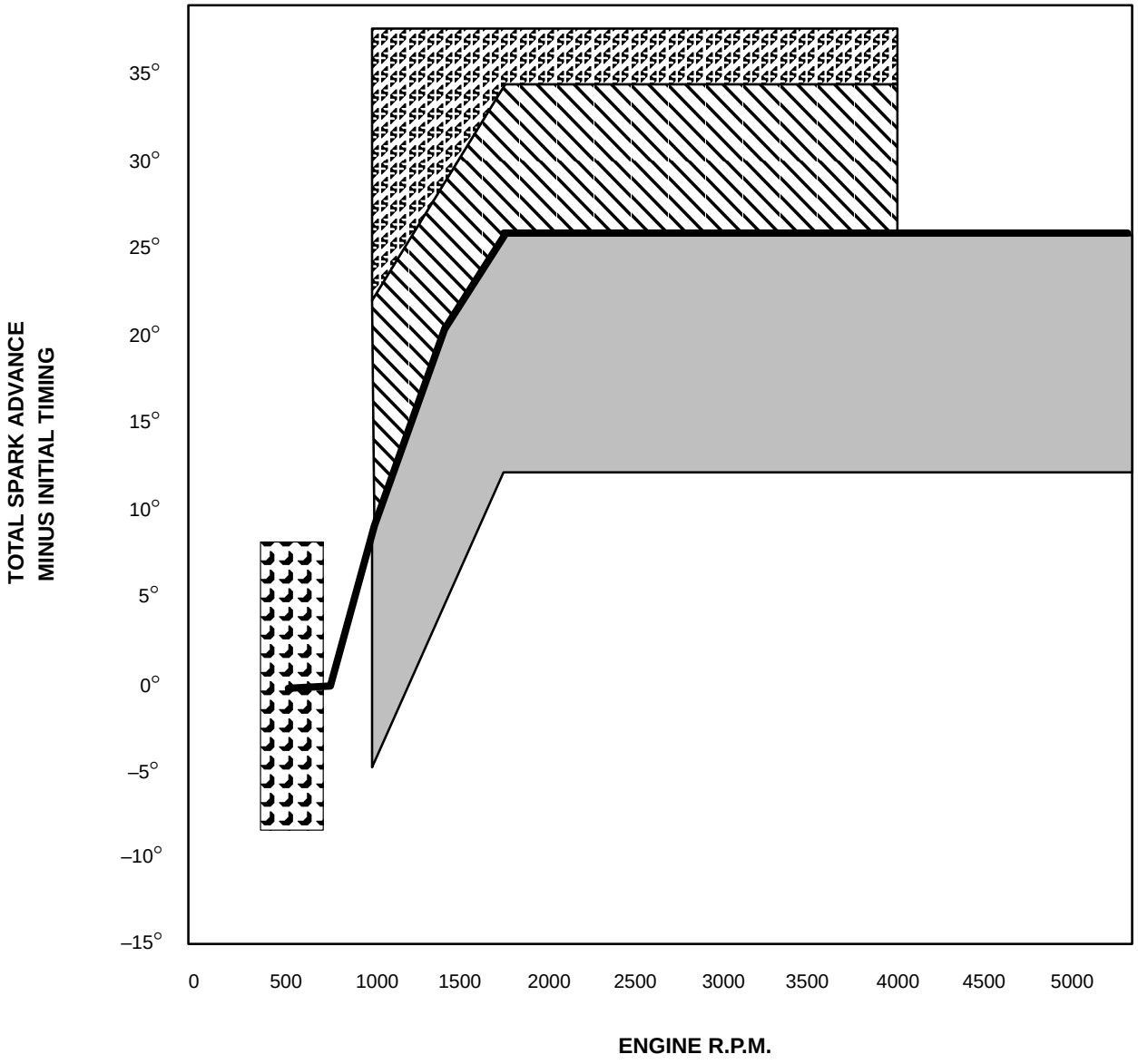
Thunderbolt V Spark Control Graph

IMPORTANT: The graph below shows the typical advance ranges for a Thunderbolt V ignition control module. The numbers plotted on the graph are not representative of any particular model. It is only presented to provide an understanding of how the system functions.



= Base Timing Advance Curve

= Idle Speed Advance Range

= Knock Retard Range

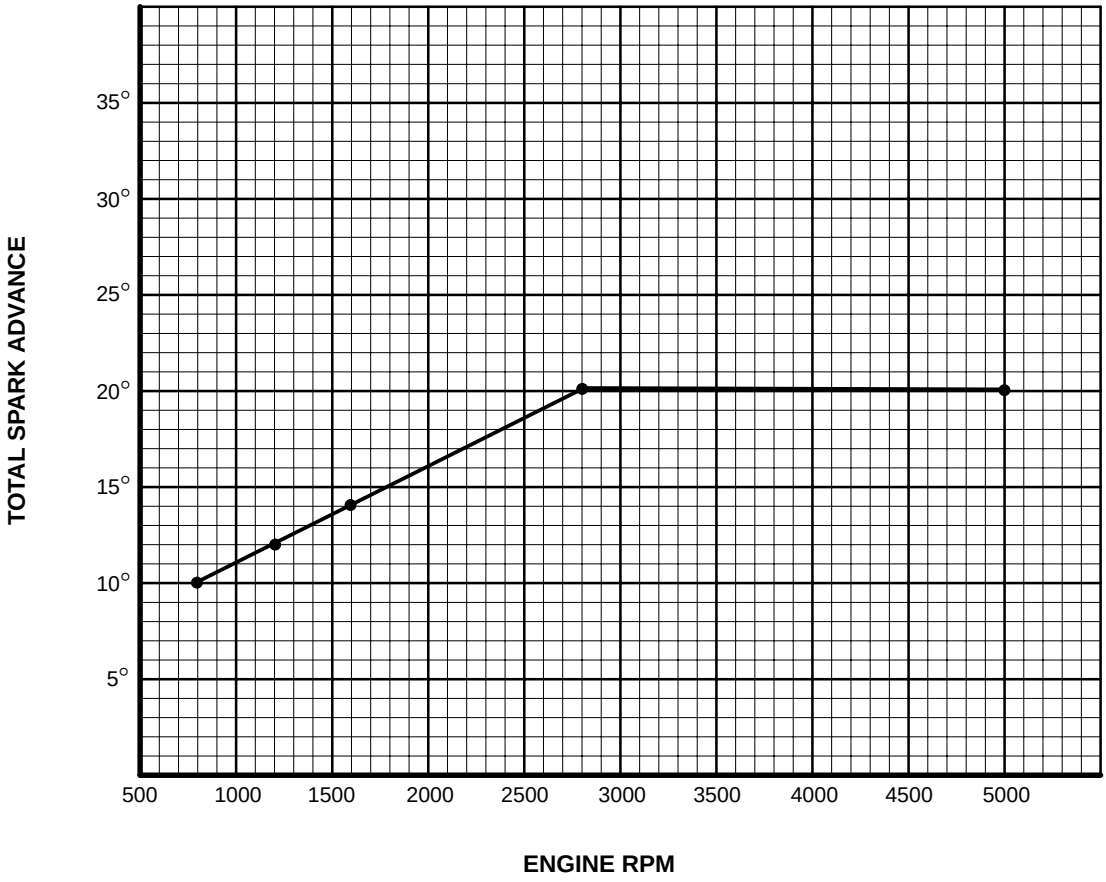
= Acceleration Advance Range

= MBT Advance Range

Index

Distributor Advance Curves

1. Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.
2. The spark advance is controlled by the ignition module.



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Distributor

Removal

1. Unplug wiring harness from ignition amplifier on distributor housing.
2. Remove distributor cap. Do not remove high tension leads unless necessary.
3. Crank engine over until timing marks line up and rotor is pointing toward No. 1 cylinder on distributor cap.
4. Mark distributor housing in reference to engine block.
5. Remove bolt and hold-down clamp and remove distributor.
6. To simplify distributor installation, do not turn crankshaft when distributor is removed from engine.

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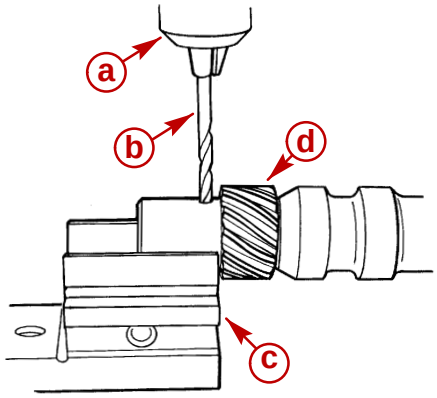
Disassembly

1. Remove rotor, sensor wheel and sensor.
2. Remove roll pin, washer and driven gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is .002 in. (0.05 mm).
4. Remove shaft from housing and check shaft for being bent with a dial indicator and V-blocks. Maximum runout is .002 in. (0.5 mm).

Reassembly

1. Lubricate shaft with engine oil. Install E-clip (if removed) on shaft in housing.
2. Install washer on shaft. Install original gear; slide onto shaft and install roll pin.
3. Hole may be offset and gear will only fit in one direction.
4. If installing a new gear, the gear will come drilled on one side. Slide gear onto shaft; align hole in gear with hole in shaft. Using these holes as guides, drill through other side of gear with a 3/16 in. carbide tripped drill.
5. If a new gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new gear installation.



72735

a - Drill Press
b - 3/16 In. Carbide Tip Drill
c - V - Block
d - New Gear

6. Install sensor, sensor wheel and rotor.
7. Install distributor.

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Installation - Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.
4. It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.
5. Replace and tighten distributor hold-down bolt and clamp. Connect leads. Also install spark plug and coil secondary wires, if removed.
6. Install cap. Refer to “Spark Plug Wires ” and install wires.
7. Plug wiring harness into ignition amplifier on distributor housing.
8. Time ignition as outlined under “Ignition Timing.”

Installation - Engine Disturbed

⚠ CAUTION

If timing chain has been aligned as outlined in Section 3A - “Timing Chain and Sprocket,” the No. 4 cylinder is on compression (TDC) and the distributor MUST BE installed with the rotor positioned at the No. 4 post on the distributor cap.

Electrical timing on No. 1 spark plug remains the same as outlined following.

1. Locate No. 1 piston in firing position by either of two methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley, or
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug. Install cap.
6. Refer to “High Tension Leads” and install wires. Refer to “Specifications” for firing order.
7. Time ignition as outlined under “Ignition Timing.”

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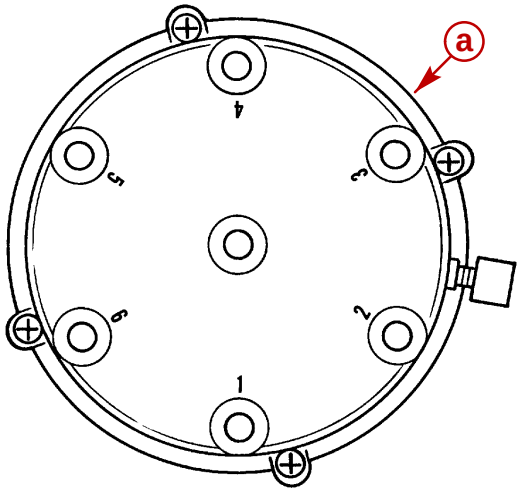
Distributor Cap

Removal

1. Loosen four distributor cap retaining screws.
2. Remove distributor cap.

Inspection

1. Clean cap with warm soap and water and blow off with compressed air.
2. Check cap contact for excessive burning or corrosion. Check center contact for deterioration.
3. Check cap for cracks or carbon tracks using magneto analyzer.
4. Check condition of distributor cap gasket. Replace gasket if damaged or missing.
5. If high tension leads are removed from cap refer to ”Spark Plug Wires” in this section and the following illustrations for installation.



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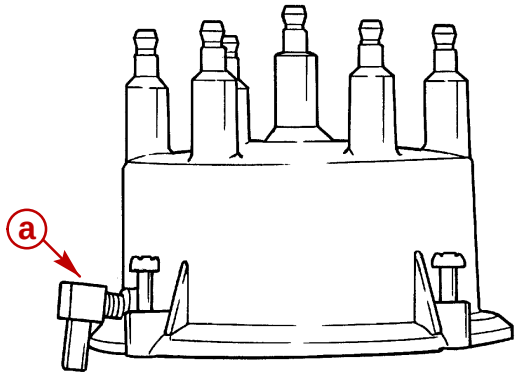
Wiring

a - Alignment Notch



72978

a - Vent

Rotor/Sensor Wheel

Removal

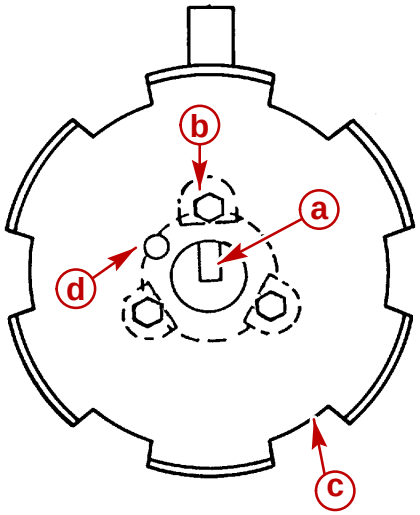
1. Remove distributor rotor/sensor wheel assembly from distributor shaft. Rotor and sensor wheel are secured to the shaft with Loctite. Use two flat blade screwdrivers. The screwdrivers are positioned opposite each other with the blade tips on the underside of the rotor and sensor wheel assembly. Make sure blade tips are toward distributor shaft until they come in contact with shaft. A downward push on both screwdriver handles at the same time will pry off rotor/sensor wheel assembly. The use of torch lamp will also aid in the removal of the rotor/sensor wheel assembly.

⚠ WARNING

Wear protective gloves when handling heated rotor/sensor wheel assembly to avoid severe burns.

Inspection

1. With the rotor/sensor wheel assembly removed, inspect the locating key inside the rotor.
2. The locating key will appear as a clean edged, 1/8 in. (3 mm) wide, sloped ramp at the bottom of the splined hole.



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a - Locating Key
b - Screws (Hex Head)
c - Sensor Wheel
d - Locating Pin

3. If there is any doubt if sensor wheel is located properly, lay sensor wheel on top of the figure above with sensor fingers facing up (toward you). Line up three screw holes and locating pin hole on sensor wheel with the figure. If wheel is indexed properly all the fingers on wheel will line up with those in the figure.
4. If there are pieces of material shaved off the key or if it appears to have been damaged by being forced down while misaligned with slot in distributor shaft, the rotor must be replaced.
5. Check rotor for burned or corroded center contact.
6. Check rotor for cracks and carbon tracks using magneto analyzer and instructions supplied with analyzer.

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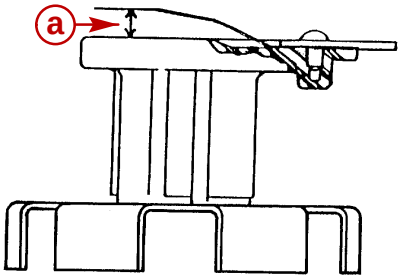
7. If rotor is damaged, replace rotor by removing three hex bolts and separating sensor wheel from rotor. Reinstall sensor wheel to new rotor making sure locating pin on rotor is installed in locating hole in sensor wheel. Tighten three hex bolts securely.
8. Bend carbon brush tang upward slightly until a distance of 1/4 in. (6.4 mm) is obtained between rotor and tang.



72979

a - 1/4 in. (6.5 mm)

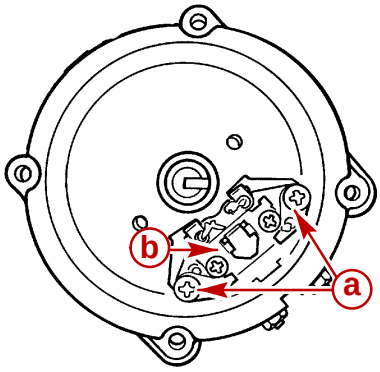
Installation

1. Put 2 drops of Loctite 27131 into the rotor so it lands on the locating key.
2. Put 2 drops of Loctite 27131 in keyway on upper portion of distributor shaft.
3. Immediately install rotor assembly onto distributor shaft. Make sure rotor locating key is aligned with keyway in distributor shaft before pressing rotor all the way down on the shaft, until it stops, with the palm of your hand. Let Loctite cure overnight with distributor in inverted position.
4. The rotor should fit very tight. It may be necessary to heat rotor with torch lamp to properly install. It is important not to let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.
5. Reinstall distributor cap on distributor.
6. Install spark plug wires (if removed). Refer to “Spark Plug Wires” in this section.

Sensor

Removal

1. Remove rotor and sensor wheel.
2. Remove two screws that hold sensor into distributor housing.
3. Remove sensor from housing.



72732

a - Mounting Screws
b - Sensor Assembly

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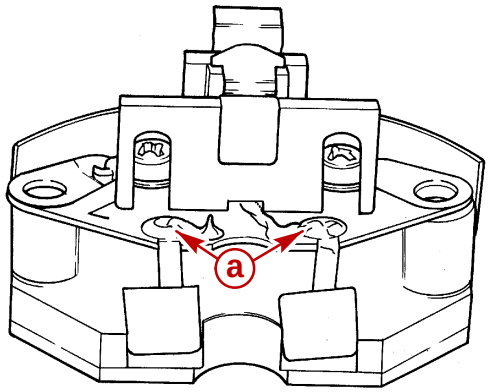
Inspection

1. Use a magnifying glass and light to inspect the two metal “jumper leads” for cracks. If a crack is found in either metal “jumper lead,” install a new sensor.



72733

a - Jumper Leads

⚠ CAUTION

Do not use any type of silicone sealer on the inside of the distributor. Most silicone sealers give off an acidic vapor during the curing stage of the sealer. This acid can cause corrosion on the ignition components.

Installation

1. Install sensor into housing and install two retaining screws.
2. Install sensor wheel, rotor and distributor cap.

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ELECTRICAL SYSTEM

Section 4C - Charging System

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4C

General Precautions

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the “Troubleshooting Tests,” following.
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

EFI Electrical System Precautions

⚠ CAUTION

Avoid damage to the EFI electrical system and components. Refer to the following precautions when working on or around the EFI electrical harness or when adding other electrical accessories:

- **DO NOT tap accessories into engine harness.**
- **DO NOT puncture wires for testing (Probing).**
- **DO NOT reverse battery leads.**
- **DO NOT splice wires into harness.**
- **DO NOT attempt diagnostics without proper, approved Service Tools.**

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

IMPORTANT: Alternators are equipped with an excitation circuit. This circuit will have approximately a 7 milliamp draw on the battery with the key in the off position. This draw is normal.

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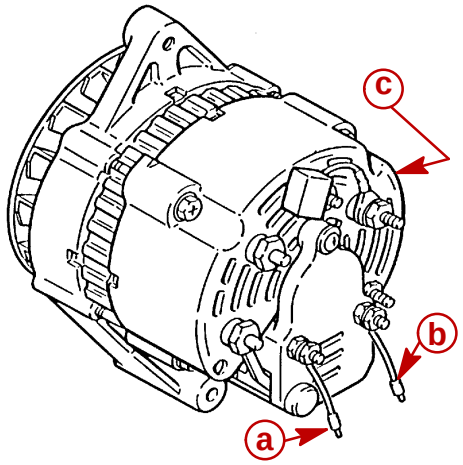
Identification



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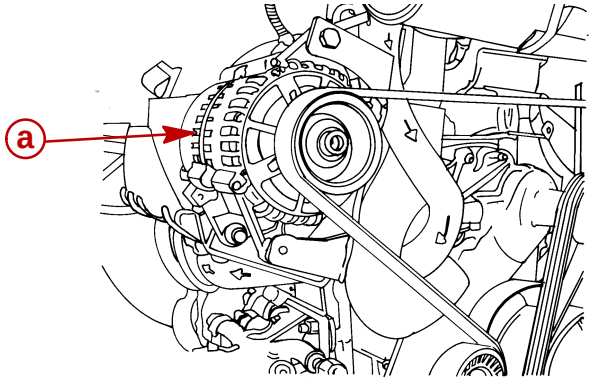
Mando 55 Amp and 65 Amp Alternator (S/N 0L619083 and Below)

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Part Number and Amperage Rating (Hidden In This View)



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Delco 65 Amp Alternator (S/N 0L619084 and Above)

a - Part Number

Specifications

Mando

Description	Specification	
	55 Amp	65 Amp
Part Number	807652T	807653T
Excitation Circuit	1.3 to 2.5 Volts	1.3 to 2.5 Volts
Current Output	50 Amp. Min.	60 Amp. Min.
Voltage Output	13.9 to 14.7 Volts	13.9 to 14.7 Volts
Min. Brush Length	1/4 in. (6 mm)	1/4 in. (6 mm)

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DelcoRemy

Description	Specification
Part Number	862031T
Rating	12 (V) x 65 (A)
Output (1300 / 2500 / 6500 Grpm)	8 / 47 / 65 (A) @ 20’
Regulator Setting Voltage	14.4 - 15 Volts @ 25’

Tools

Description	Part Number
Bearing Removal and Installation Kit	91-31229A7
Universal Puller Plate	91-37241
Ammeter (0-100 Amp)	Obtain Locally
Multimeter	91-854009A1

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
End Frame Screws	55		5.5
Brush Setscrews	18		1.5
Regulator Mounting Screws	42		4.2
Regulator Leads	25		2.5
Ground Terminal Nut	25		2.5
Pulley Nut		42	57
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
Belt Tension	See Note		
Ground Terminal Nut (Delco 65 Amp Alternator)	55		5.5
Pulley Nut (Delco 65 Amp Alternator)		70	95

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Normally this location is between the power steering pump and the belt adjustment pulley. This location will be different on engines with closed cooling or models without power steering.*

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Description

This package uses an integral regulator charging system. The integrated circuit regulator is a solid state unit that is mounted inside the alternator to the slip ring end frames. All regulator components are enclosed in a solid mold to protect them from the heat and corrosive elements. The regulator voltage cannot be adjusted.

The alternator rotor gears contain enough grease to eliminate the need for periodic lubrications. Two brushes carry current through two slip rings to the field coil mounted on the rotor. Under normal conditions, this arrangement is capable of providing long periods of attention free service.

Stator windings are assembled inside a laminated core that is mounted between the alternator drive end frame and the slip ring end frame. A rectified bridge that contains six diodes is connected to the stator winding. These diodes electrically change stator AC voltage into DC voltage. This DC voltage is then transmitted to the alternator output terminal.

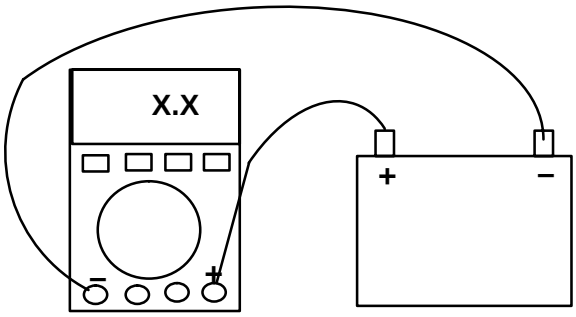
A capacitor or condenser, mounted in the regulator, protects the rectifier bridge. This capacitor also suppresses radio noise.

NOTE: *There are no repair or replacement internal parts for this alternator. The alternator has to be replaced as a complete assembly. The only part that is available is the pulley.*

Testing

Charging System

1. Check belt condition and tension.
2. Check battery condition.



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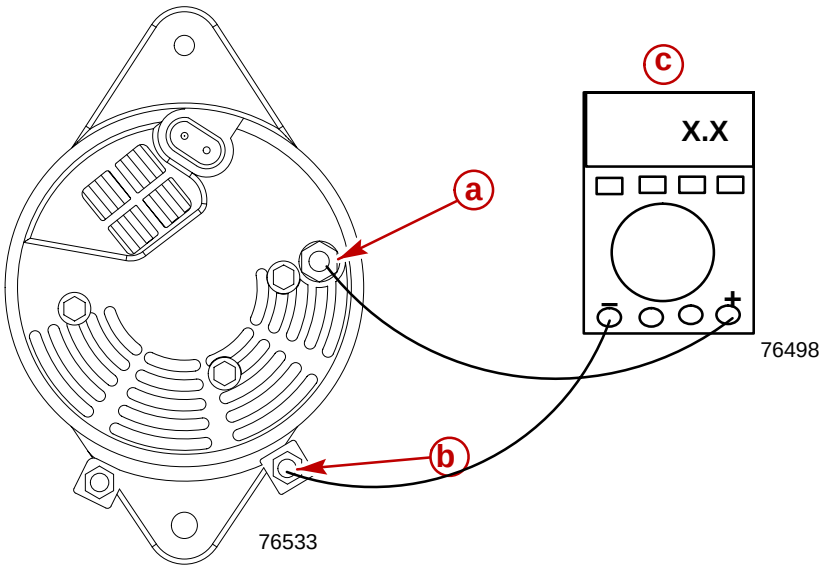
3. With a fully charged battery, connect voltmeter leads directly to the battery posts.
4. Start engine and run at 1300-1500 rpm. Read voltmeter. Most systems will read 13.8-14.8 volts.

NOTE: *If the voltage reading is within specifications, switch voltmeter to AC volt position. There should not be more than a 0.250 AC voltage reading with the engine running. A reading more than 0.250 AC volts indicate defective diodes in the alternator.*

5. If the voltmeter reading at the battery posts is below 13.5 volts, connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the ground terminal on the alternator. Repeat step 4.



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76533

Typical

a - Output Terminal
b - Ground Terminal
c - Voltmeter

6. If voltmeter reading is now within specifications, there is too much resistance between the alternator and the battery.
7. If the reading is below 12.5 volts, the alternator may not be charging. Check all wiring leading to the alternator.

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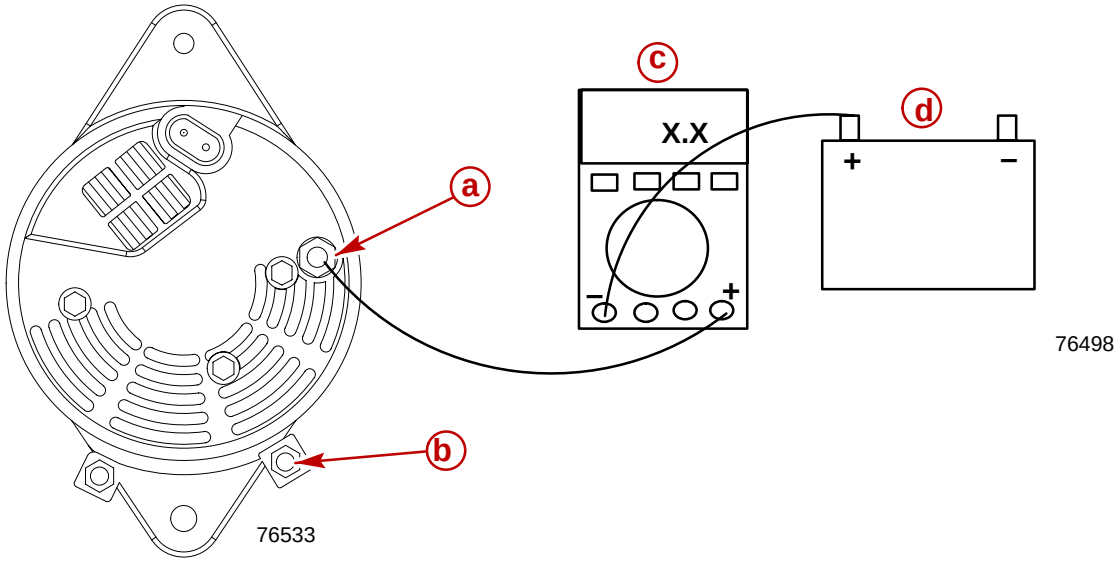
Charging System Resistance

1. Ground the ignition coil high tension wire so engine does not start.
2. Crank engine over for 15 seconds to discharge the battery slightly.
3. Reconnect coil high tension wire and turn off all accessories.
4. Connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the battery positive (+) post.

NOTE: *Connect voltmeter leads to the battery post, NOT the battery cable end.*

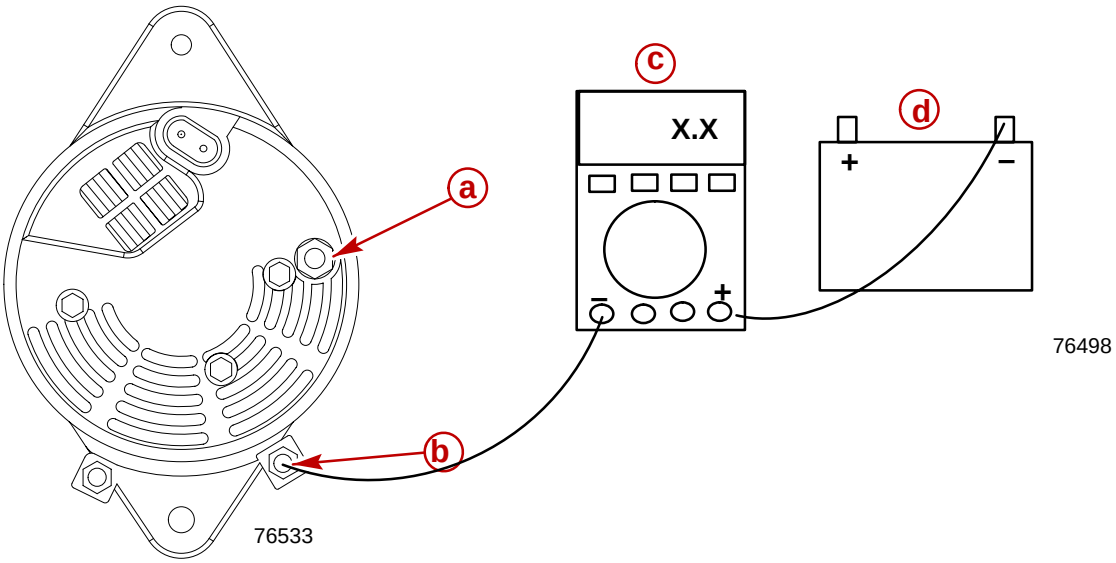


Typical

a - Output Terminal
b - Ground Terminal
c - Voltmeter
d - Battery

5. Start engine and run at 1300–1500 rpm. Read voltmeter. A reading of more than 0.5 volts show excessive resistance in wiring.

6. Connect the voltmeter negative (–) lead to the alternator ground terminal. Connect voltmeter positive (+) lead to the battery negative (–) post.



Typical

a - Output Terminal
b - Ground Terminal
c - Voltmeter
d - Battery

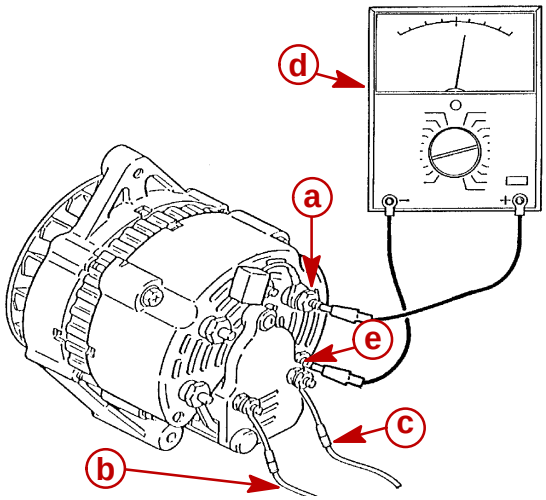
7. Repeat Step 5.

Circuitry

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

OUTPUT CIRCUIT

1. Ensure battery is fully charged by using the hydrometer test outlined in 4A.
2. Start engine and increase RPM to approximately 1500 rpm.
3. Check voltage reading. The voltage should read between 13.8 and 14.2 volts. If the reading is below 13.8 volts:
   a. Connect positive (+) voltmeter lead to alternator output post.
   b. Connect negative (–) lead to ground post on alternator.
   c. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximate battery voltage and should not vary. If no reading is obtained, or if reading varies, go to “Resistance” in this section.



72784

Typical

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

EXCITATION CIRCUIT

1. Connect positive (+) voltmeter lead to tie strap terminal on alternator and negative (–) lead to a ground terminal on alternator (Test 1).
2. Turn ignition switch to ON position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug PURPLE lead from regulator. Connect positive voltmeter lead to PURPLE lead and negative voltmeter leads to ground (Test 2). If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.

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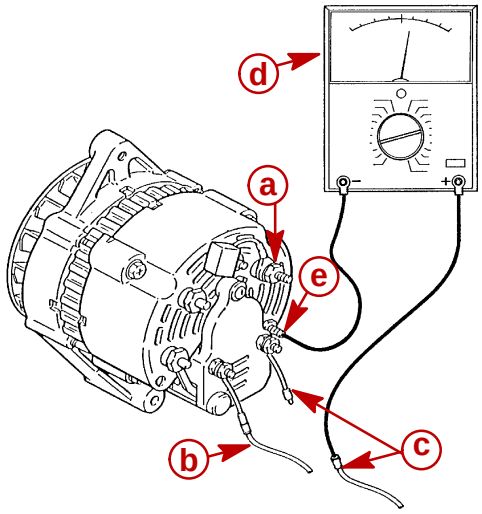
SENSING CIRCUIT

1. Unplug RED/PURPLE lead from voltage regulator.
2. Connect positive (+) voltmeter lead to red/purple lead and negative (–) voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/purple lead) for loose or dirty connection or damaged wiring.



72786

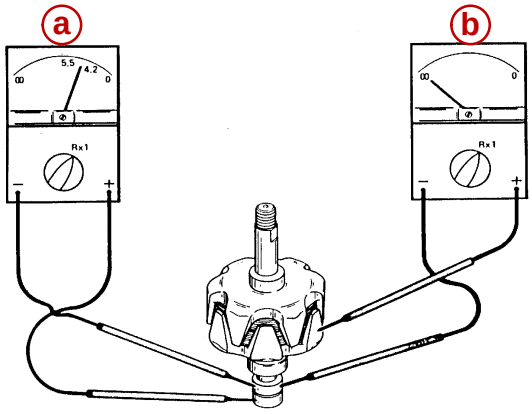
Typical

- **a** - Output Wire - ORANGE
- **b** - Excitation Wire - PURPLE
- **c** - Sensing Wire - RED/PURPLE
- **d** - Voltmeter (0-20 Volts)
- **e** - Ground

Component

ROTOR

1. Test rotor field circuit for opens, shorts or high resistance (Test 1), using an ohmmeter (set on R x1 scale), as follows:



72831

Testing Rotor Field Circuit

- **a** - Test 1
- **b** - Test 2

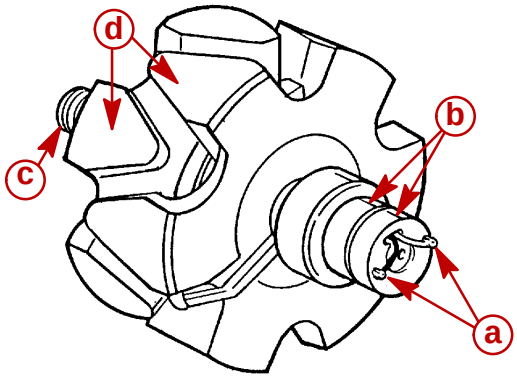
a. Connect one ohmmeter lead to each slip ring.

b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature 70-80°F (21-26°C).

Index

c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.

d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also, be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.



73112

a - Field Winding Leads
b - Slip Rings
c - Rotor Shaft
d - Pole Pieces

2. Test rotor field circuit for grounds (Test 2), using an ohmmeter (set on R x1 scale) as follows:

   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.

   b. Meter should indicate no continuity (meter should not move).

   c. If continuity does exist, complete rotor assembly must be replaced.

IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, due to centrifugal force. Replace rotor if all other electrical components test good.

STATOR

IMPORTANT: Stator leads MUST BE disconnected from rectifier for this test.

1. Test stator for grounds (Test 1), using an ohmmeter (set on R x1 scale) as follows:

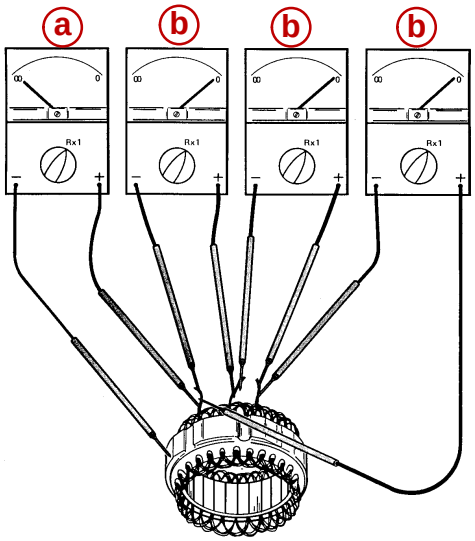
   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.

   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.

2. Test for opens in stator (Test 2), using an ohmmeter (set on R x1 scale) as follows:

   a. Connect ohmmeter between each pair of stator windings (three different ways).

b. Continuity should be present in all three cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.



72833

Testing Stator

a - Test 1
b - Test 2

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sure sign of a short.

RECTIFIER AND DIODE ASSEMBLY

NOTE: *Failure of any component in tests following will require replacement of entire rectifier assembly.*

NEGATIVE (–) RECTIFIER

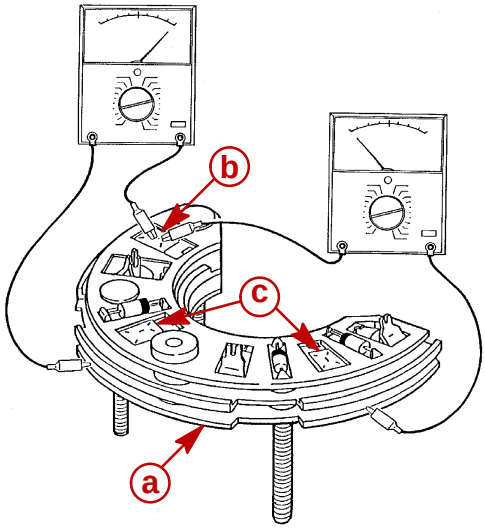
IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

⚠ CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to negative (–) rectifier heat sink and the other lead to one of the rectifier terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1. through 3. for two other rectifiers in heat sink.

5. Replace assembly if any of the rectifiers is shorted or open.



72147

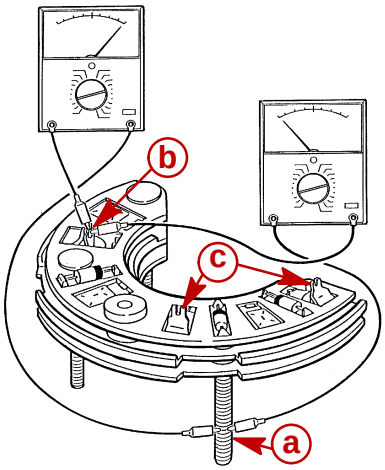
a - Heat Sink
b - Rectifier Terminal
c - Test These Two Rectifiers In The Same Manner

POSITIVE (+) RECTIFIER AND DIODES

⚠ CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to 1/4 in. stud on positive (+) rectifier heat sink and the other lead to one of the rectifier terminals. Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1. through 3. for two other rectifiers in heat sink.



72834

a - Stud
b - Rectifier Terminal
c - Repeat Test Between These Terminals And Stud

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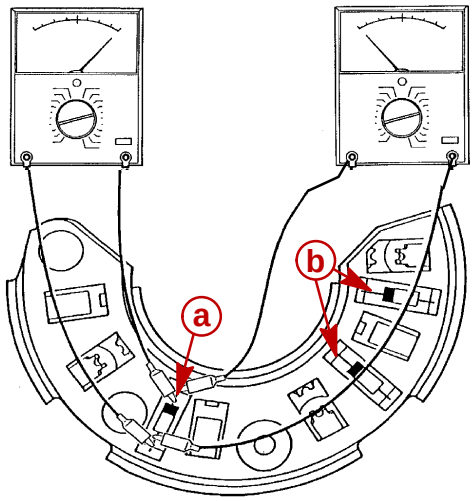
5. Replace assembly if any one of the rectifiers is shorted or open.
6. Connect one lead of an ohmmeter (set on R x1) to the common side of the diode and the other lead to the other side, of one of the three diodes.



72148

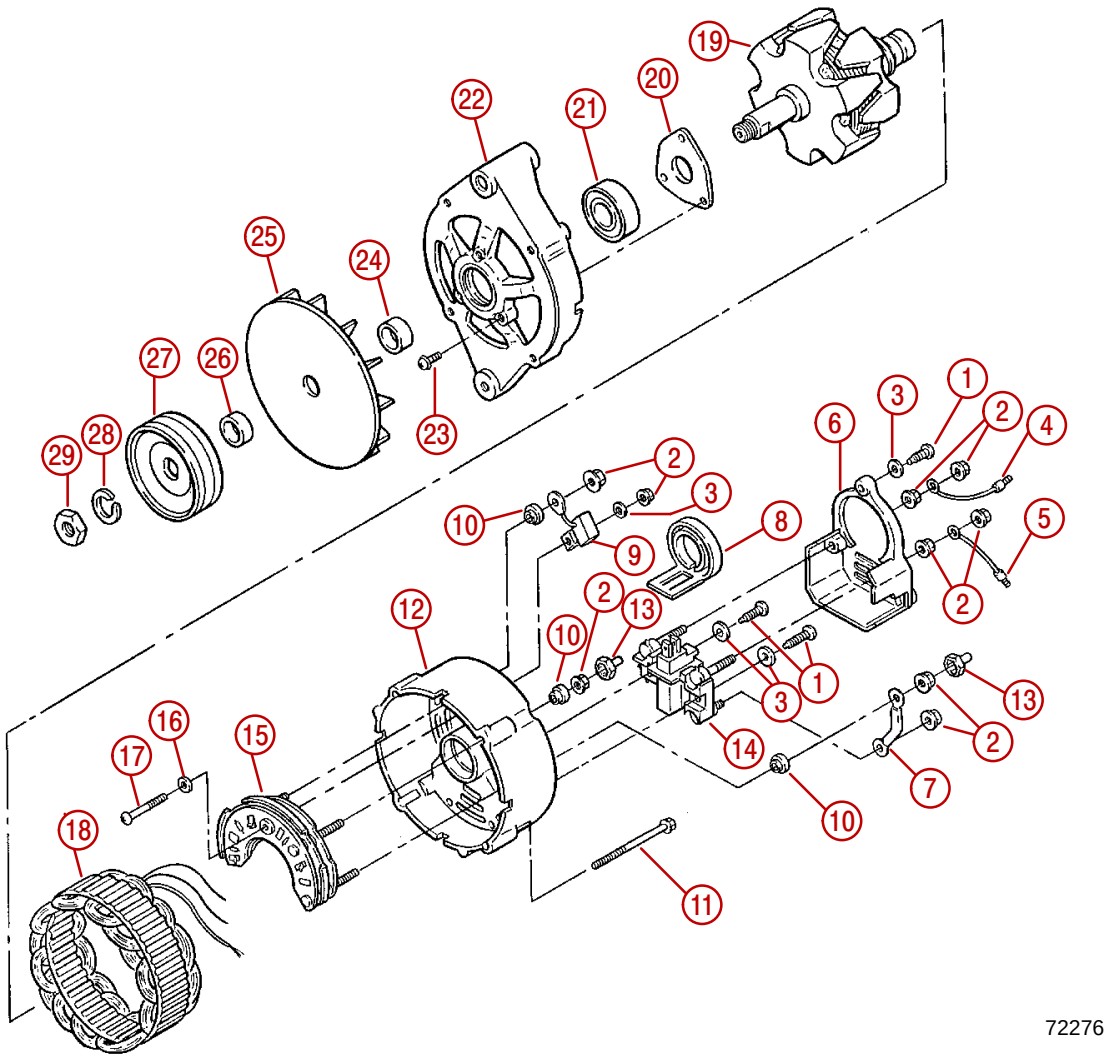
a - Common Side Of Diode Circuit Board
b - Repeat Test For Two Diodes

7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
9. Repeat Steps 1. through 3. for the other two diodes.
10. Replace rectifier assembly if any one of the diodes is shorted or open.

CONDENSER

1. Using magneto analyzer and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd).
   b. Condenser Short or Leakage Test.
   c. Condenser Series Resistance Test.
2. Replace condenser if test results are not within specifications.

Exploded View



1 - Screws (3)
2 - Nut (9)
3 - Flat Washer (4)
4 - Sensing Wire (RED / PUR)
5 - Excitation Wire (PUR)
6 - Cover
7 - Tie Strap
8 - Rubber Gasket
9 - Condenser
10 - Insulator
11 - Bolt (4)
12 - End Frame (Rear)
13 - Cap (2)
14 - Brush / Regulator Assembly
15 - Rectifier Assembly
16 - Flat Washer
17 - Screw
18 - Stator
19 - Rotor And Slip Ring
20 - Retaining Plate
21 - Front Bearing
22 - End Frame (Front)
23 - Screw (3)
24 - Fan Spacer
25 - Fan
26 - Pulley Spacer
27 - Pulley
28 - Lockwasher
29 - Nut

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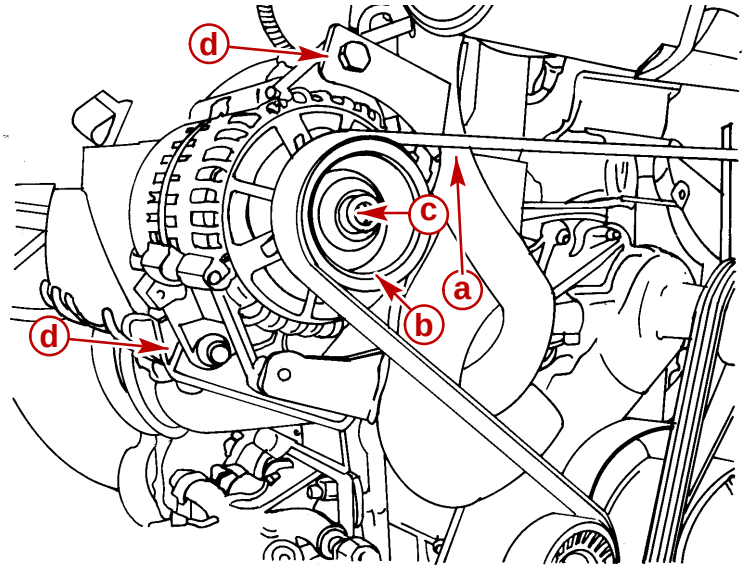
Alternator Repair

Removal

1. Disconnect negative (–) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Loosen serpentine belt with the adjustment pulley.
4. Turn the adjustment stud and loosen belt. Remove belt.
5. Remove alternator mounting bolt, washers and remove alternator.



76465

Delco Alternator Shown, Mando Similar

a - Serpentine Belt
b - Adjustment Pulley
c - Adjustment Stud
d - Mounting Bolt

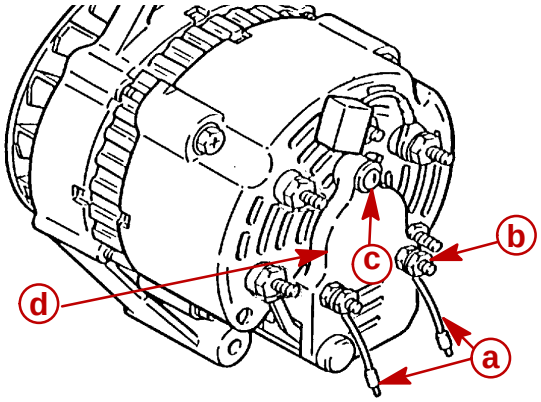
Disassembly

NOTE: *Mando Alternator shown throughout, Delco Alternator should be replaced if it tests defective*

IMPORTANT: The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise so that rear end frame is facing you.

2. Disconnect regulator leads from terminals on rear end frame. Remove four nuts, Phillips head screw and two regulator leads. Then pull regulator cover away from rear end frame.



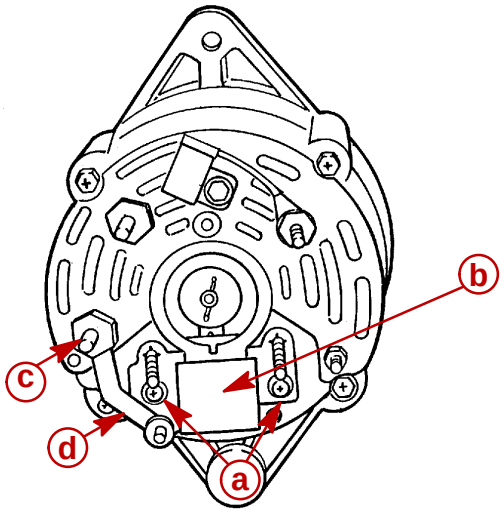
72963

a - Regulator Leads
b - Nuts (4)
c - Phillips Head Screw
d - Regulator Cover

3. Remove stud cover insulator, two nuts and tie strap from brush/regulator assembly.

IMPORTANT: Scribe pieces during disassembly to assist in exact same positioning during reassembly.

4. Remove two brush/regulator attaching screws and remove brush/regulator assembly.



72823

a - Screws
b - Brush / Regulator Assembly
c - Stud Cover Insulator
d - Tie Strap

5. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.

6. Remove four screws which secure end frames and stator together.

IMPORTANT: DO NOT insert screwdriver blades more than 1/16 in. (1.5 mm) into openings (in next step), as stator windings may be damaged.

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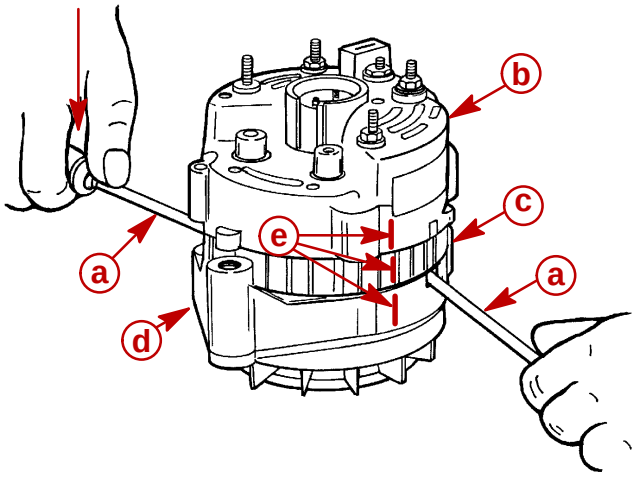
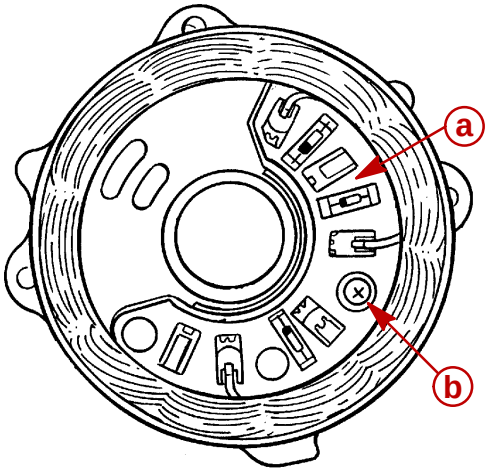
7. Separate rear end frame and stator assembly from front end frame and rotor assembly using two thin blade screwdrivers (positioned 180 degrees apart from one another) at the locations shown. Use the two slots shown to initially separate units.



72824

a - DO NOT Insert Screwdriver Blades More Than 1/16 In. (1.5 mm) Into Slots.
b - Rear End Frame
c - Stator
d - Front End Frame
e - Scribe Marks

8. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from output and ground studs.
9. Turn end frame over (stator upward) and remove one Phillips head screw which secures rectifiers to end frame.

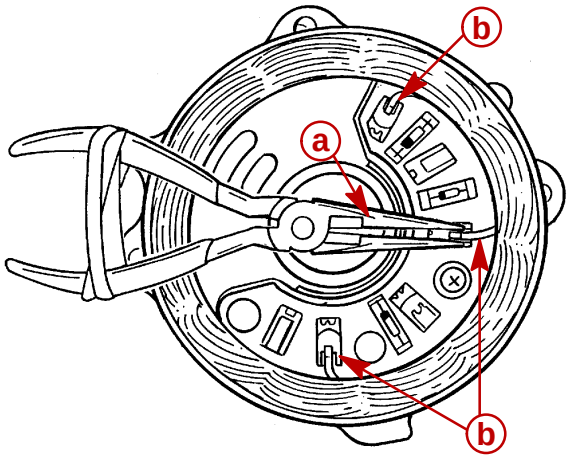


72826

a - Rectifier Assembly
b - Phillips Head Screw

10. Separate stator and rectifier assembly from rear end frame using screwdriver slots.

11. Unsolder the three stator leads from the rectifier heat sink. Place a needle nose pliers on diode terminal between solder joint and diode body to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



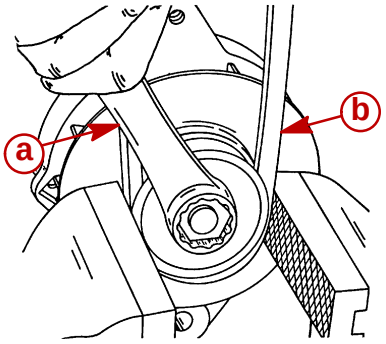
72827

a - Heat Sink
b - Stator Leads (3)

IMPORTANT: With alternator disassembled to this point, stator, rectifier, diodes, and rotor may be tested, as explained under "Component Testing," following.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

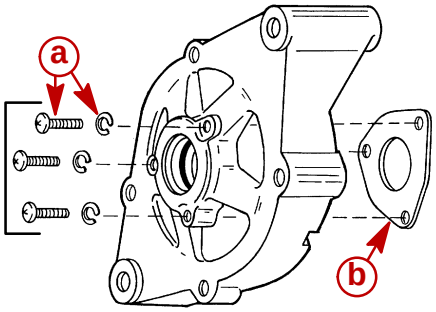
12. Remove pulley retaining nut by clamping pulley in a vise (using an old belt or protective jaws to protect pulley) and turning nut counterclockwise with a wrench. Remove lockwasher, slide pulley and fan from shaft. If pulley is difficult to remove, it may be necessary to use a universal puller.



72828

a - Wrench
b - Old Belt To Protect Pulley

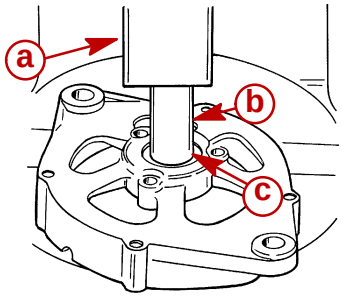
13. Remove the three phillips head screws and lockwashers which secure the front bearing retaining plate.



72829

a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

14. Remove front bearing from front end frame using an arbor press and a suitable size mandrel. Discard bearing.



72830

a - Press
b - Mandrel
c - Bearing

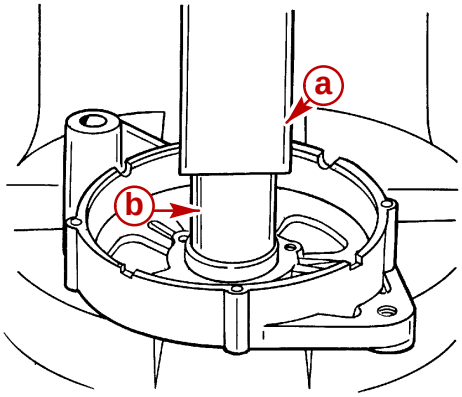
15. If rotor slip rings or rear bearing requires replacement, entire rotor must be replaced. Parts cannot be purchased separately.

Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:
   a. **Brush/regulator assembly** - inspect for cracked casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than 1/4 in. (6 mm) long.
   b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor-slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002 in. (0.051 mm) maximum] and replace rotor, if present.
   d. **Rotor shaft and front end bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) and excessive side or end play. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
   g. **Fan** - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).
   h. **Pulley** - inspect pulley mounting bore end for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks and corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth or drive belt wear will be greatly accelerated.

Reassembly

1. Install new front bearing into front end frame bearing bore using an arbor press. If necessary, use a bearing driver that contacts outer race only.



72835

a - Press
b - Mandrel

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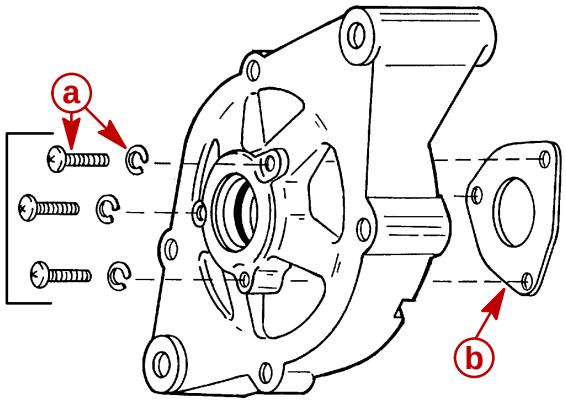
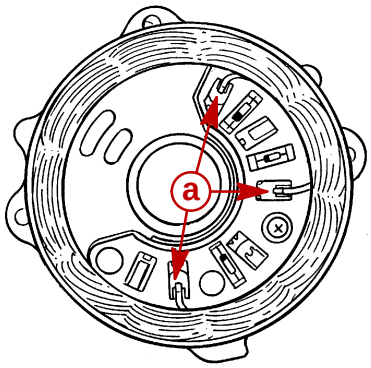
2. Install front bearing retaining plate using three Phillips head screws and lockwashers.



72829

a - Phillips Head Screws And Lockwashers
b - Front Bearing Retaining Plate

3. Slide front end frame over rotor.
4. Assemble stator to rectifier by soldering the three leads to the three rectifier terminals.



72826

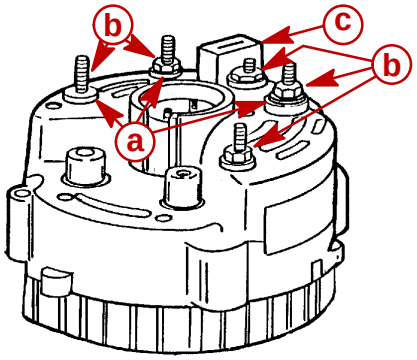
a - Stator Lead Connections

NOTE: *Be sure to connect leads to their original positions.*

5. Install assembled stator and rectifier assembly into rear end frame, aligning scribe marks on each (scribed during disassembly), and install Phillips head screw and washer to retain.

IMPORTANT: The insulating washers MUST BE installed as shown or damage to the alternator will result.

6. Position stator down with rear end frame up and reinstall insulators, nuts and condenser.



72561

a - Insulators (3)
b - Nuts (5) One Removed
c - Condenser

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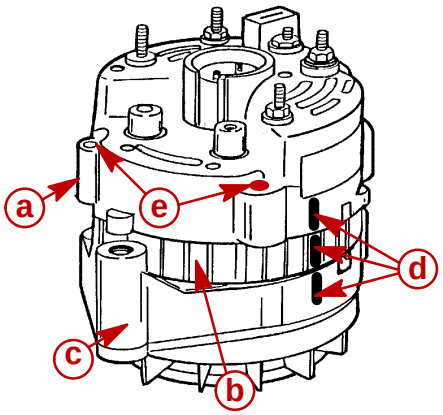
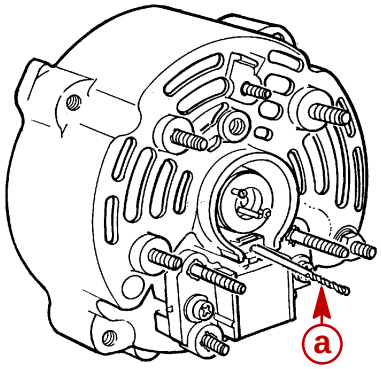
7. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install four screws. Tighten screws securely.



72561

a - Rear End Frame
b - Stator
c - Front End Frame
d - Scribe Marks
e - Insert Screws (4) (Two Hidden)

8. Depress brushes flush with top of brush holder and insert a #54,.050 in. (1 mm) drill bit or smaller into hole in brush holder to hold brushes compressed during reassembly.

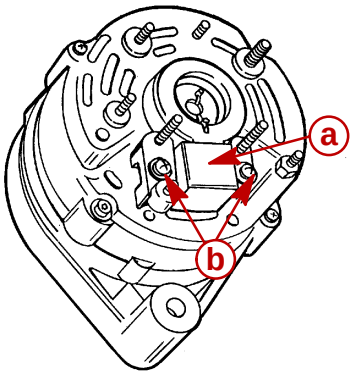


72836

a - Drill Bit

NOTE: *Rubber gasket shown removed for clarity.*

9. Install brush/regulator assembly in rear end frame cavity and secure with two mounting screws, as shown. Tighten screws securely. Remove drill bit to release brushes against slip rings.

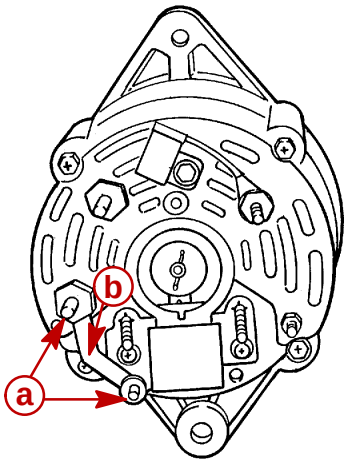


72837

a - Brush / Regulator Assembly
b - Mounting Screws

Index

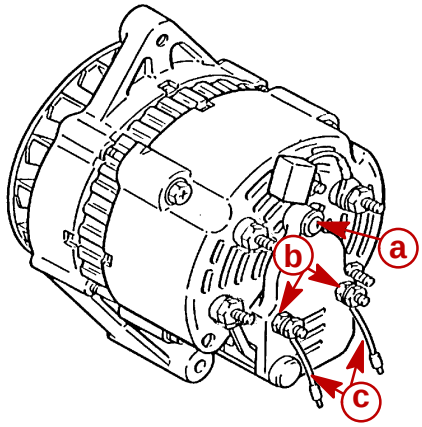
10. Install tie bar to rectifier stud and stud on brush/rectifier assembly. Tighten nuts securely.



72823

a - Studs
b - Tie Bar

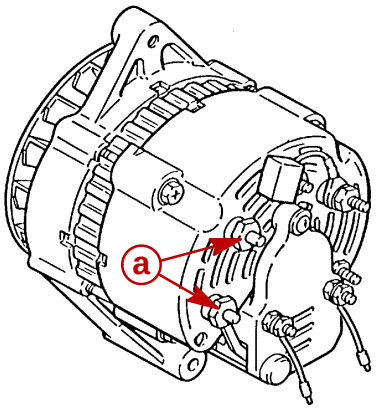
11. Install cover with one phillips head screw and two nuts. Install two leads with nuts.



72963

a - Phillips Head Screw
b - Nuts (4)
c - Leads

12. Install insulator caps.



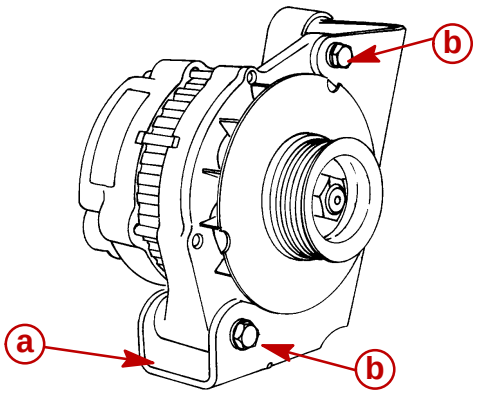
72078

a - Insulator Caps

Index

Installation

1. Position alternator in mounting bracket and install mounting bolts. Torque to 35 lb-ft (48 Nm).

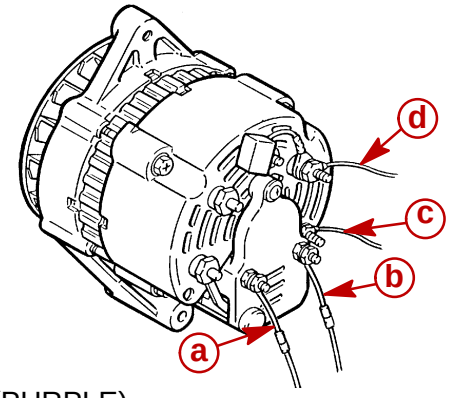


75713

Typical Models

a - Bracket
b - Bolts

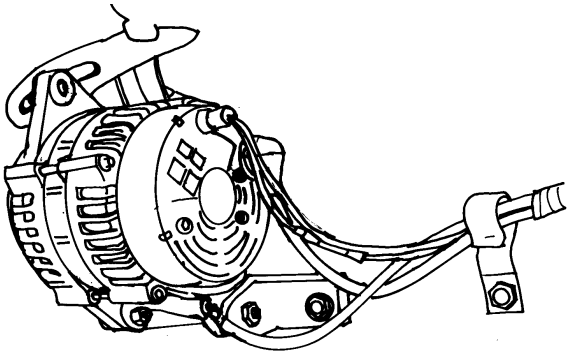
2. Position alternator drive belt on pulleys and adjust tension as explained under “Drive Belt Tension Adjustment,” preceding.
3. Reconnect wiring harness to alternator.



72838

a - Excitation Lead -(PURPLE)
b - Sensing Lead - (RED / PURPLE)
c - Ground Lead - (BLACK)
d - Output Lead - (ORANGE)

4. Attach wires to engine with clip.



76093

5. Connect negative battery cable to battery.

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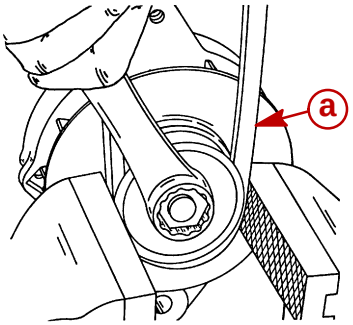
Pulley Removal

1. Remove serpentine belt.
2. Clamp pulley in a vise (using an old belt or protective jaws to protect pulley) to remove nut.

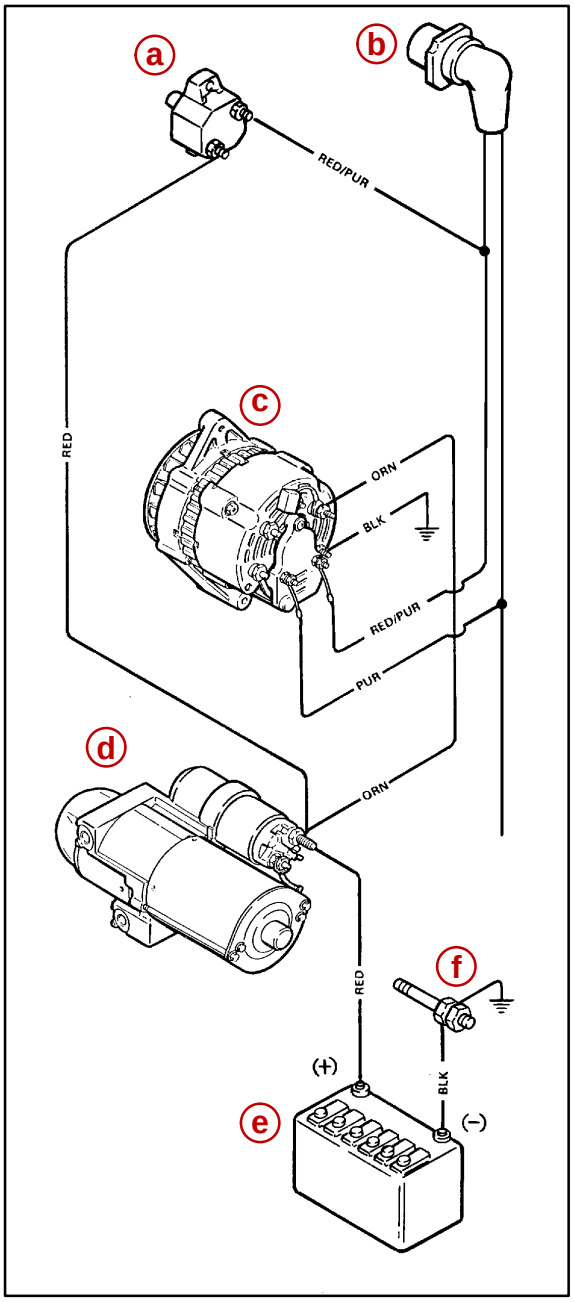


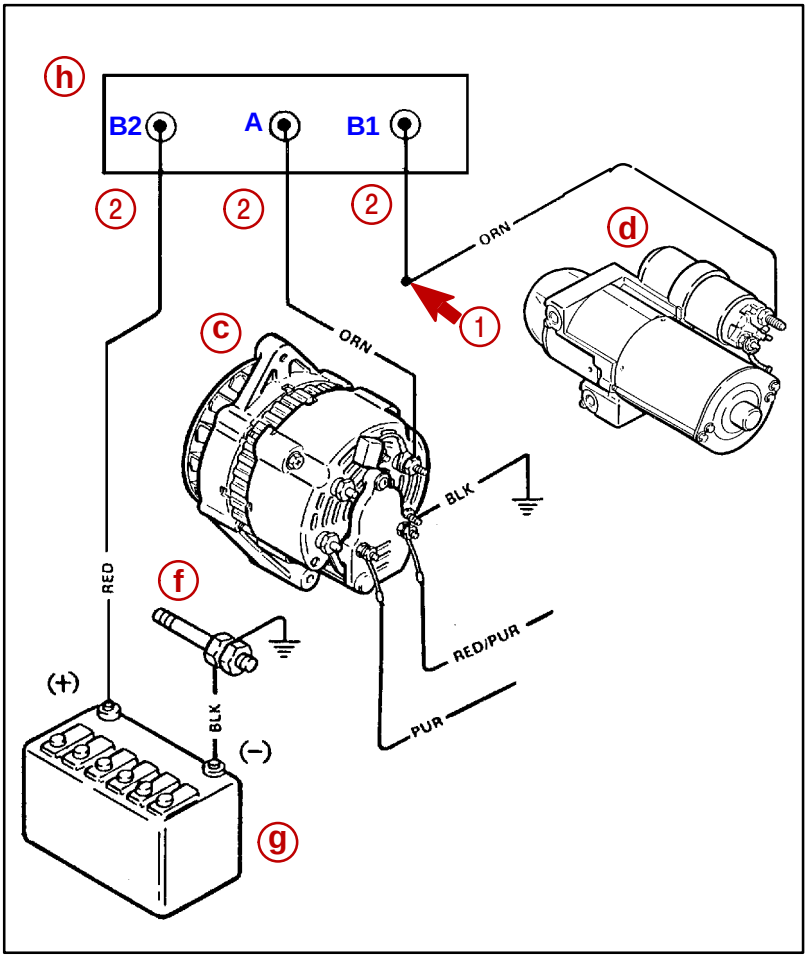
72828

a - Old Belt to Protect Pulley

3. Slide components off of alternator shaft.
4. Install components and pulley on alternator shaft.
5. Torque pulley adjustment nut to specifications.

Battery Isolator Diagram





72934

a - Circuit Breaker
b - Harness Connector
c - Alternator
d - Starter
e - Cranking Battery
f - Ground Stud
g - Auxiliary Battery
h - Isolator

1 - Disconnect Orange Wire From Alternator Battery Terminal. Splice Sufficient Gauge Wire To The Orange Wire And Connect As Shown.
2 - 8 Gauge Minimum

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ELECTRICAL SYSTEM

Section 4D - Instrumentation

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4 D

Tools

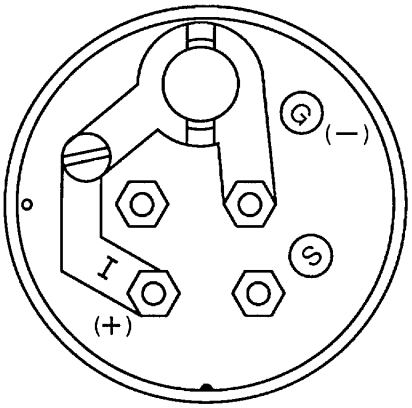
Description	Part Number
Voltmeter	Obtain Locally
Ohmmeter	
Service Tachometer	
Continuity Meter	

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Loctite Pipe Sealant with Teflon	Obtain Locally

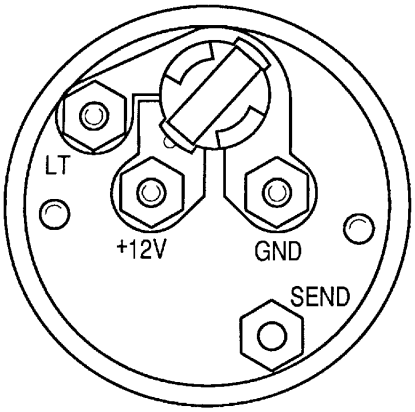
Identification

NOTE: *One of three distinct lines (Series) of Quicksilver gauges may be installed (if equipped with Quicksilver gauges). Aside from different gauge face appearances and styling, the back of the gauges and wiring connections are different as shown.*



72746

Back of Commodore and International Series Gauge - Typical



72965

Back of QSI Series Gauge - Typical

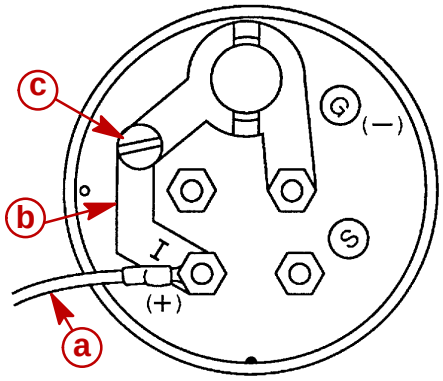
Special Information

Lighting Options

COMMODORE AND INTERNATIONAL SERIES

These gauges may be wired so that the illumination lighting is provided from the ignition switch or a separate instrumentation lighting switch.

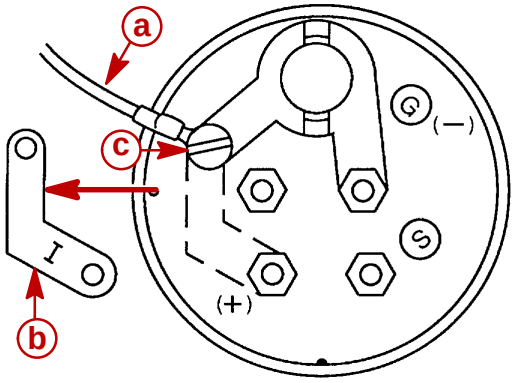
By removing contact strip “I” from between + terminal and the screw as shown following, and supplying a separate +12 V power supply to the screw connection, illumination lights can be operated independent of ignition switch.



72966

Ignition Switch Lighting Circuit

- **a** - Positive (+) 12 Volt Power Supply From Ignition Switch
- **b** - Contact Strip “I”
- **c** - Screw Connection



72967

Separate Instrumentation Lighting Circuit Wiring

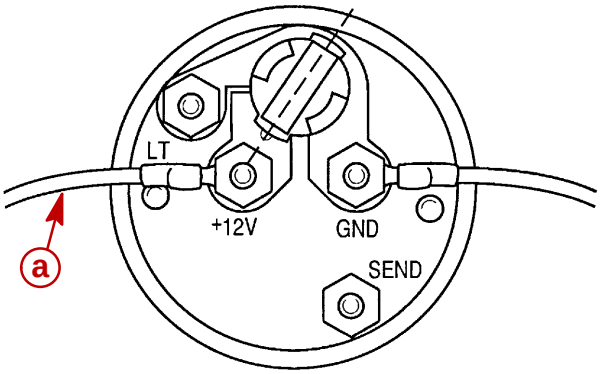
- **a** - Positive (+) 12 Volt Power Supply From Ignition Switch
- **b** - Contact Strip “I”
- **c** - Screw Connection

QSI SERIES

These gauges are equipped with optional illumination lighting. Light bulb socket can be removed and contacts can be aligned to be used with ignition switch lighting circuit +12 V or separate instrumentation lighting circuit LT.

IMPORTANT: Light socket must be removed from gauge and turned counterclockwise (facing back of gauge) when adjusting to desired setting. Turning socket while still installed in gauge could result in damage to gauge or socket.

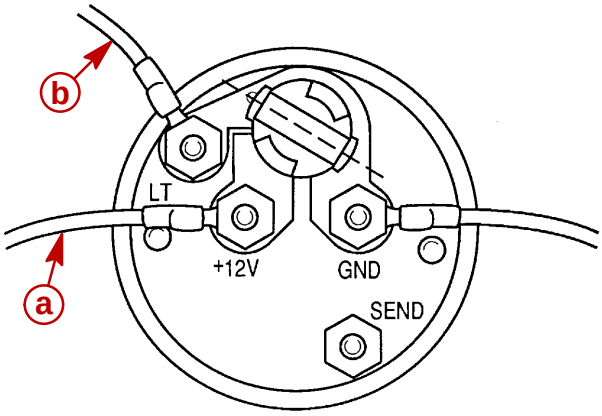
NOTE: *For different lighting effects, colored sleeves are available through the Quicksilver Accessories and can be assembled to the bulb.*



72968

Ignition Switch Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition Switch



72969

Separate Instrumentation Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition
b - Positive (+) 12 Volt Power Supply From Separate Instrumentation Lighting Circuit

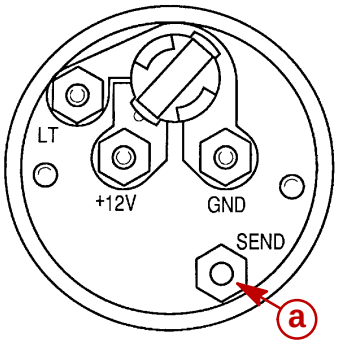
Gauges

Oil, Fuel and Temperature

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

TESTING

1. Turn ignition switch to OFF.
2. Remove wire from terminal S (SEND).

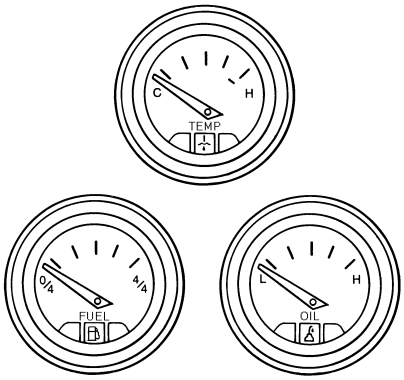


72965

Typical

a - Terminal S (SEND)

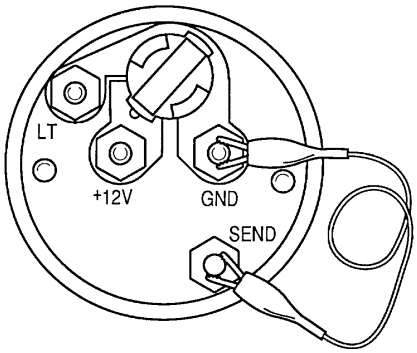
3. Turn ignition switch to RUN. Gauge being tested must be at position A.



72747

Position A (Typical)

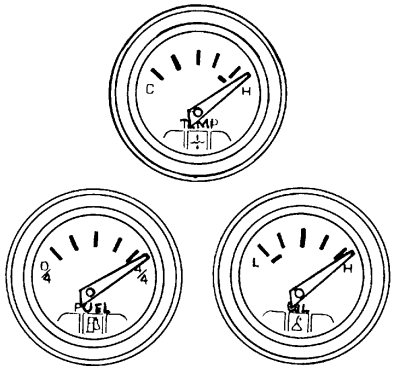
4. Turn ignition switch to OFF.
5. Connect jumper wire from terminal G (GND) to terminal S (SEND).



72748

Typical

6. Turn ignition switch to RUN.
7. Indicator needle of gauge being tested must read at position B. If not, replace gauge.



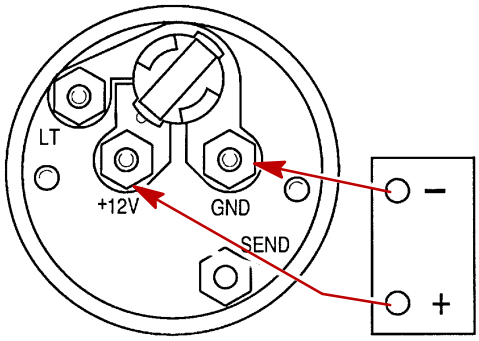
72749

Position B (Typical)

Battery Gauge

TESTING

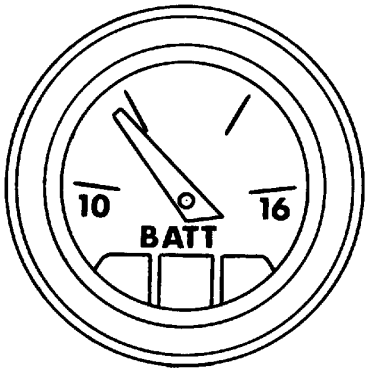
1. Remove cables from battery and fully charge battery.
2. Connect negative (–) jumper lead from battery to gauge terminal G (GND).
3. Connect positive (+) jumper lead from battery to gauge terminal I or +12 V.



72750

Typical

4. Check gauge reading; if not as shown replace gauge.



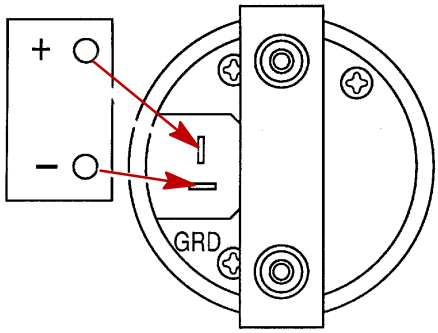
72751

Typical

Cruiselog Meter

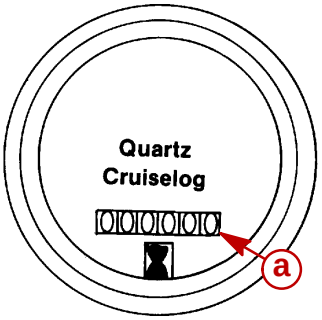
TESTING

1. Connect jumper wire from positive (+) battery terminal to positive (+) gauge terminal.
2. Connect jumper wire from negative (–) battery terminal to negative (–) gauge terminal.



72752

3. Observe gauge run indicator. If indicator is turning, gauge is operable. If not, replace gauge.



72753

a - Indicator

Vacuum Gauge

TESTING

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 rpm. Reconnect vacuum hose and compare vacuum gauge readings (at specified rpm) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

2. If gauge readings are not within specifications, gauge is defective.

Speedometer

TESTING

IMPORTANT: When testing speedometer gauge for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective.

CALIBRATION CHART

Air Pressure Gauge psi	Speedometer Gauge MPH (km/Hr)
5.3	20±2 (32±1.6)
27.8	45±1 (72±1.6)

Tachometer

TESTING

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

Tachometer	Allowance
6000 rpm	± 150 rpm
8000 rpm	± 200 rpm

Gauge Replacement

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. Remove hoses (vacuum, speedometer gauge).
4. Disconnect light socket.
5. Remove holding strap and remove gauge.
6. Position gauge assembly in appropriate mounting hole.
7. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: Do not distort case or bracket by overtightening.

8. Connect ground (BLK) wire to ground terminal, if gauge is not mounted in metal panel.
9. Connect other wires to gauge as shown in SECTION 4E.
10. Connect hoses (vacuum, speedometer gauges).
11. Install gauge light socket.
12. Coat all terminals with Quicksilver Liquid Neoprene.
13. Reconnect battery cables to battery.

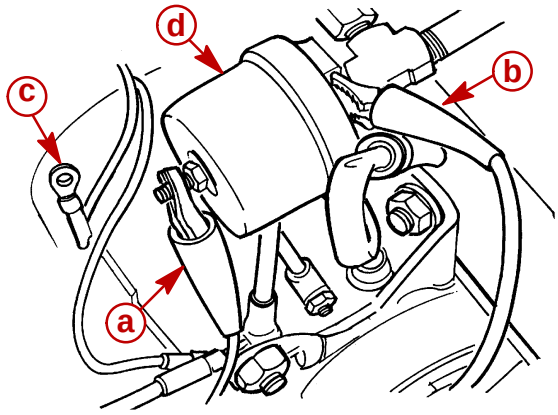
Senders

Oil Pressure

TESTING

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to SECTION 1C "Troubleshooting."

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



72754

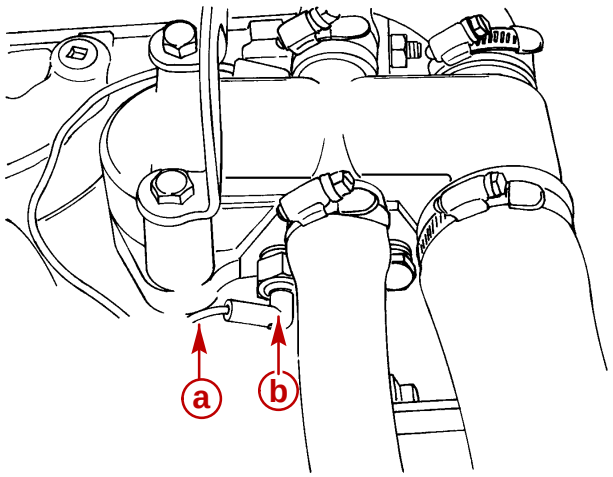
a - Positive Lead
b - Negative Lead
c - Wire Removed
d - Oil Pressure Sender

Oil Pressure (psi)	Ohms Reading	
	Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.25
40	91.7-113.6	45.8-56.8
80	9-49	4.5-24.5

Water Temperature

REMOVAL

1. Drain coolant from closed cooling system into a suitable container as outlined in SECTION 6B.
2. Remove TAN wire from temperature sender.

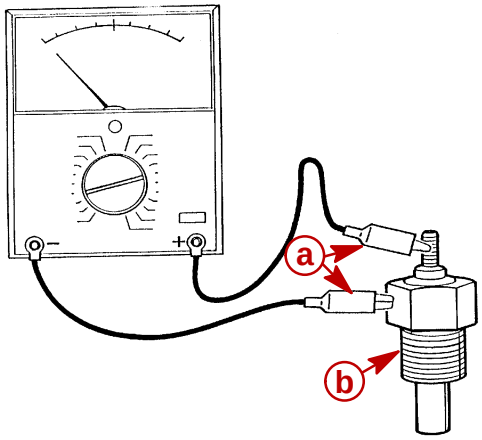


75846

a - TAN Wire
b - Water Temperature Sender

TESTING

1. Connect an ohmmeter between temperature sender terminal (+) and hex (case) for ground (–) as shown.



72768

a - Ohmmeter Leads
b - Water Temperature Sender

⚠ WARNING

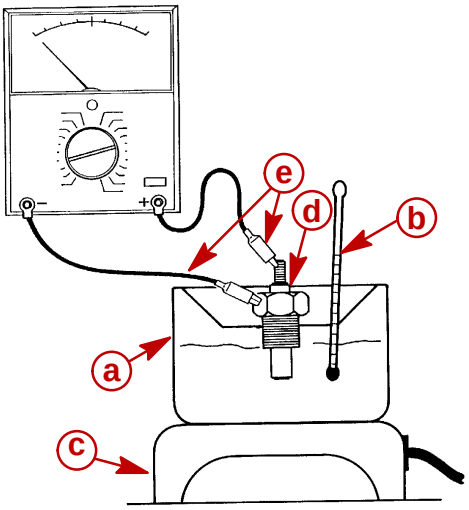
The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high-temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the water. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

2. Follow these instructions:
   a. With ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in water.
   b. Heat water and observe thermometer.
   c. As temperature rises ohmmeter readings must be within the ranges specified for each temperature (see chart below).

d. Turn heat source off. Allow water and components to cool.

NOTE: *While water cools you may recheck ohmmeter readings.*



72769

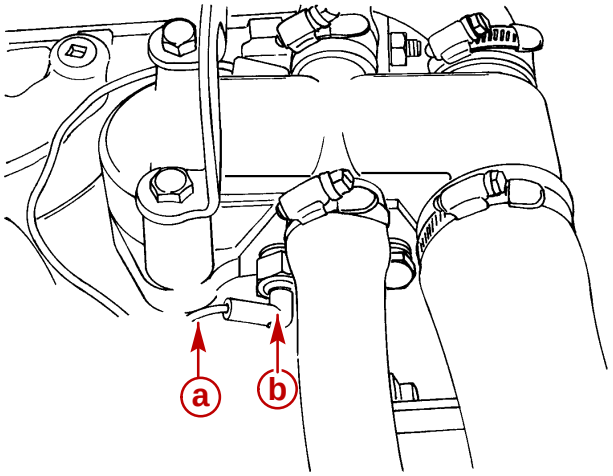
a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature
e - Ohmmeter Leads

Water Temperature	Ohms Reading
140° F (60° C)	121-147
194° F (90° C)	47-55
212° F (100° C)	36-41

3. Replace sender if ohmmeter readings are other than as shown for each temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of temperature sender.
2. Install sender in thermostat housing and tighten securely.



75846

a - TAN Wire
b - Water Temperature Sender

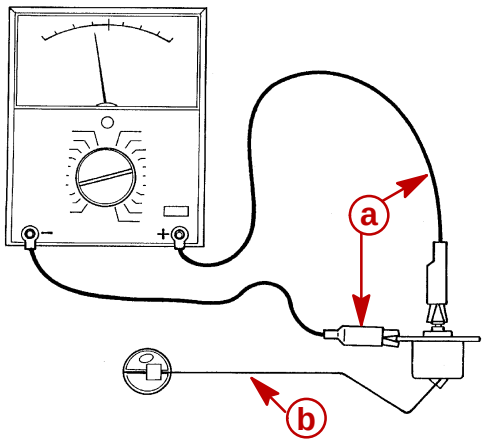
3. Connect tan wire and coat with Liquid Neoprene.
4. Refill closed cooling system with approved coolant as outlined in SECTION 6B.

Fuel Tank Sender

FLANGE TYPE

Testing

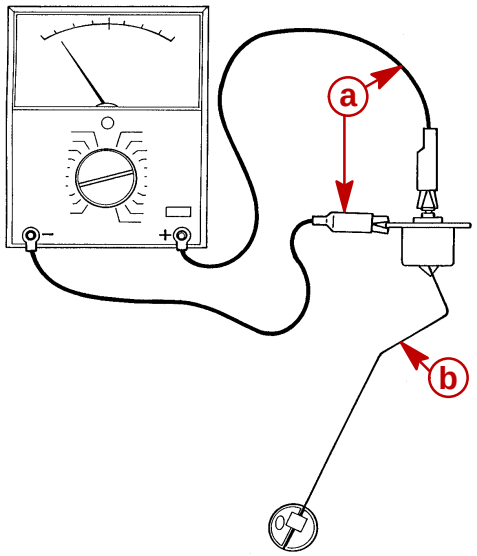
1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohmmeter between sending unit terminal and sending unit housing.
4. With float arm in FULL position (arm horizontal), ohmmeter should read 30 ohms (± 5 ohms).



72755

a - Ohmmeter Leads
b - Vertical Float Arm

5. With float arm in EMPTY position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.

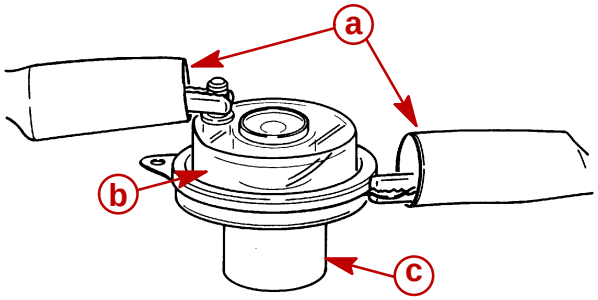


a - Ohmmeter Leads
b - Vertical Float Arm

CAPSULE TYPE

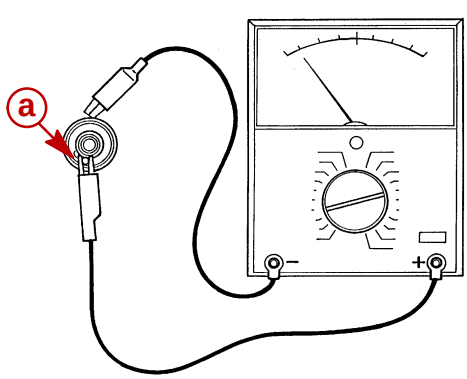
Testing

1. Disconnect wire from terminal on fuel tank capsule.
2. Remove two screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



a - Ohmmeter Leads
b - Capsule Assembly
c - Magnet

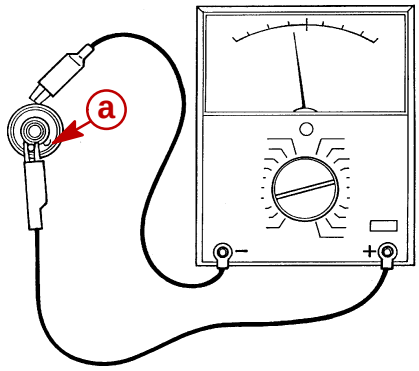
5. Turn magnet counterclockwise until fuel capsule indicator reads EMPTY. Ohmmeter should read 240 ohms (± 5 ohms).



72758

a - Capsule Reading Empty

6. Turn magnet clockwise until fuel capsule indicator reads FULL. Ohmmeter should read 30 ohms (± 5 ohms). Fuel capsule is defective if not within specifications.



72759

a - Capsule Reading Full

Switches

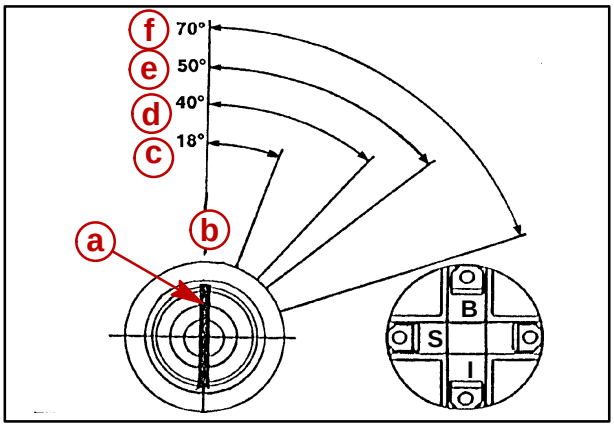
Ignition Key Switch

TESTING

⚠ CAUTION

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Disconnect battery cables, if testing ignition key switch with wires connected to switch.
2. With key switch in OFF position, there should be no continuity between switch terminals.
3. With key switch in RUN position, continuity will exist between switch terminals B to I. There should no continuity between terminal S and any other terminals.
4. With key switch in START, continuity will exist between terminals B to I and B to S.
5. Terminals are to make contact at angles shown and to stay in contact condition as switch is rotated toward START.
6. If ignition key switch tests bad, disconnect wire connections and remove switch. Test switch again, as in Steps 2-5, preceding. If switch tests good, wiring in harness is bad, There should be no continuity between any harness wires with key switch removed.



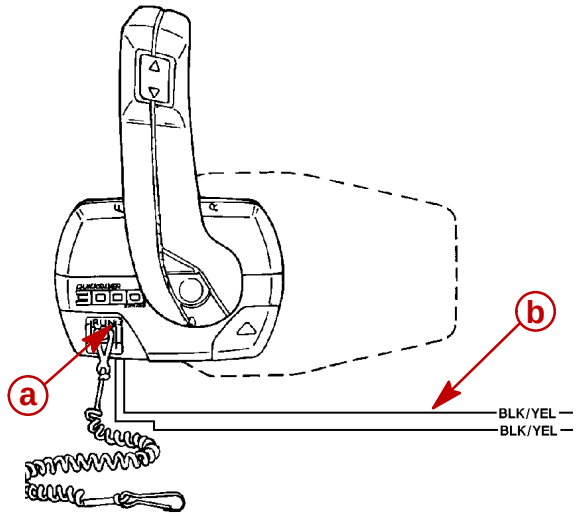
72760

Key View **Back View**

a - Key
b - Off
c - Continuity, B to I Terminals
d - Run
e - Continuity B to S Terminals
f - Start

Lanyard Stop Switches

Testing

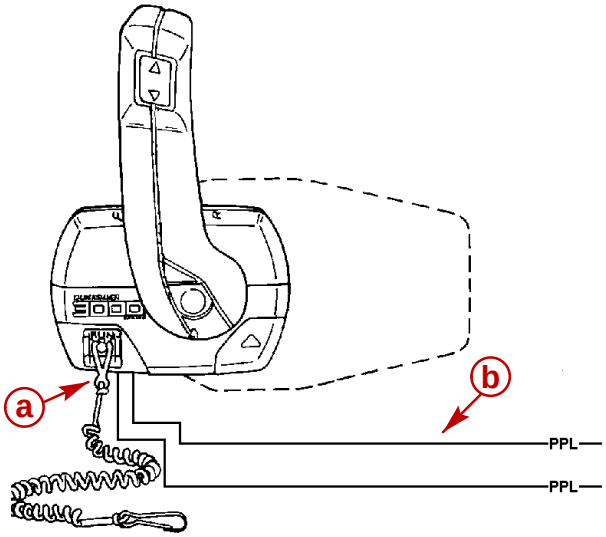


74061

Remote Control Mounted Style Switch
Electronic Fuel Injection (EFI) Engines

a - Switch Lanyard
b - Leads (BLK/YEL)

1. Disconnect switch leads.
2. Test switch as follows.
   a. Connect an ohmmeter to leads.
   b. There should be no continuity with switch lanyard connected and continuity with switch lanyard disconnected.



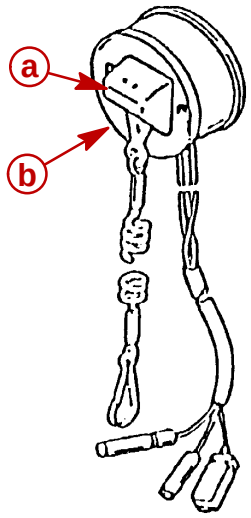
74062

Remote Control Mounted Style Switch
Carbureted Engines

a - Switch Leads
b - Leads (PUR)

Index

3. Disconnect switch leads.
4. Test switch as follows:
   a. Connect an ohmmeter to leads.
   b. There should be continuity with switch lanyard connected and no continuity with switch lanyard disconnected.



72762

Toggle Style Switch

a - Switch Cap
b - Switch

IMPORTANT: The BLK/YEL lead is not used. It should be well insulated and taped to harness.

5. Disconnect switch leads.
6. Connect an ohmmeter to switch leads.
7. Switch should have continuity with toggle in the RUN position and no continuity with toggle in the OFF position.

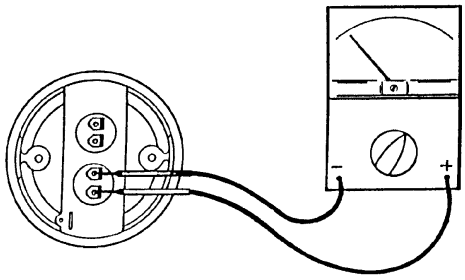
Start/Stop Switch

TESTING

⚠ WARNING

Disconnect battery leads at battery before testing.

1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.



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3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the OPEN (not depressed) state, replace panel button.

Audio Warning System

NOTICE

For repair procedures on fuel injected engines, refer to SECTION 5.

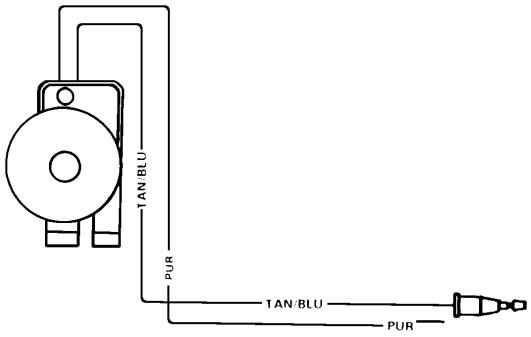
Buzzer

⚠ WARNING

The following test involves the use of electricity. Failure to follow appropriate procedures can cause burns or shock which can result in severe personal injury or death.

TESTING

1. Turn the ignition switch to the ON position without cranking the engine. The horn will sound if the system is working correctly.
2. If horn does not sound:
   a. Connect jumper wires as shown.
   b. If horn does not sound, replace it.
3. If horn worked in Step 3:
   a. Connect jumper wires as shown.
   b. Repeat Step 2.
   c. If horn sounds, problem is in TAN/BLUE wire back to engine or switches on engine.

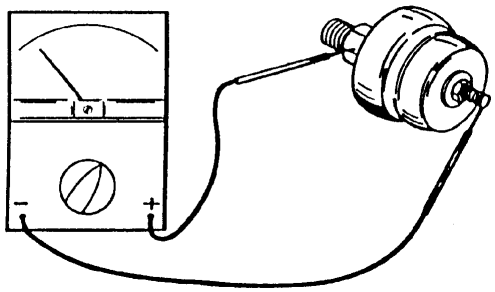


74046

Oil Pressure Switch

TESTING

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex. (Sender shown removed for clarity.)



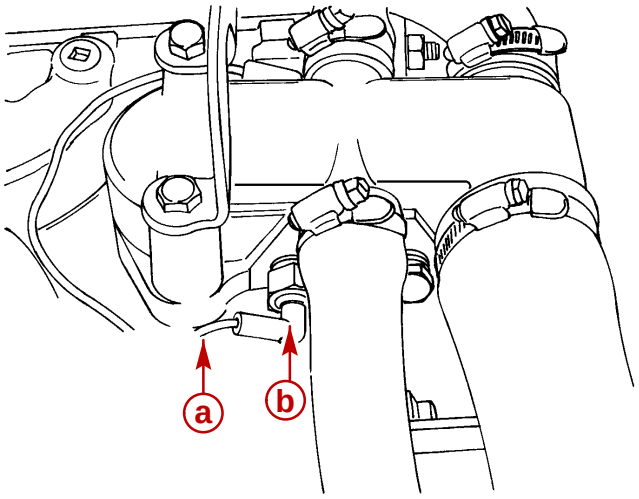
72764

3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 psi (41 kPa), meter should indicate no continuity.

Water Temperature Switch

REMOVAL

1. If equipped with closed cooling, drain coolant from closed cooling system into a suitable container. Refer to SECTION 6B.
2. Remove TAN wire from temperature switch.



72611

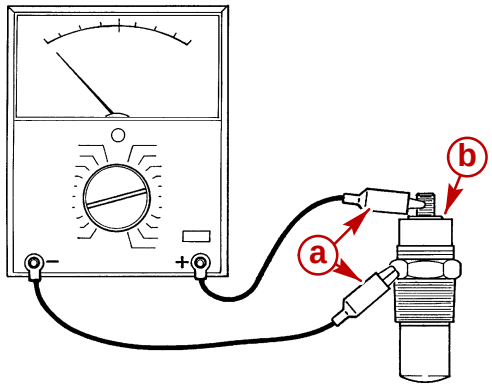
Seawater Cooled Model Shown, Closed Cooled Similar Location

a - TAN Wire
b - Water Temperature Switch

3. Remove switch.

TESTING

1. Connect an ohmmeter between water temperature switch terminal (+) and hex (case) for ground (–) as shown.



72765

a - Ohmmeter Leads
b - Water Temperature Switch

2. Switch should read no continuity.

⚠ WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

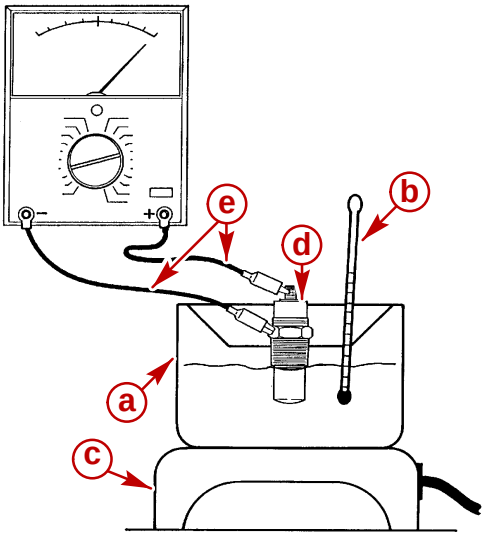
- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high- temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

⚠ WARNING

Use only clean, dry sand such as used for general sandblasting purposes. Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots, or other hazards.

3. With an ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in sand.

4. Heat sand and observe temperature on thermometer.

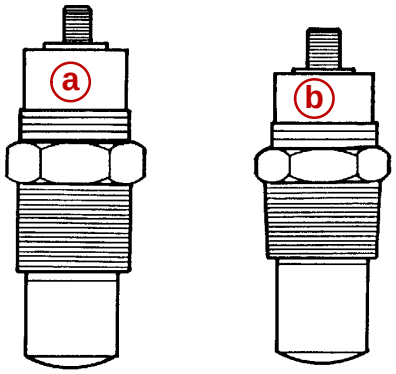


72766

a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature Switch
e - Ohmmeter Leads

5. As temperature rises, switch will close and ohmmeter will indicate continuity. Refer to chart below for specifications.

Coolant Temperature Switch		
	Opens	Closes
48952 Switch	150-170°F (66-77°C)	190-200°F (88-93°C)
87-86080 Switch	175-195°F (79-91°C)	215-225°F (102-107°C)



72767

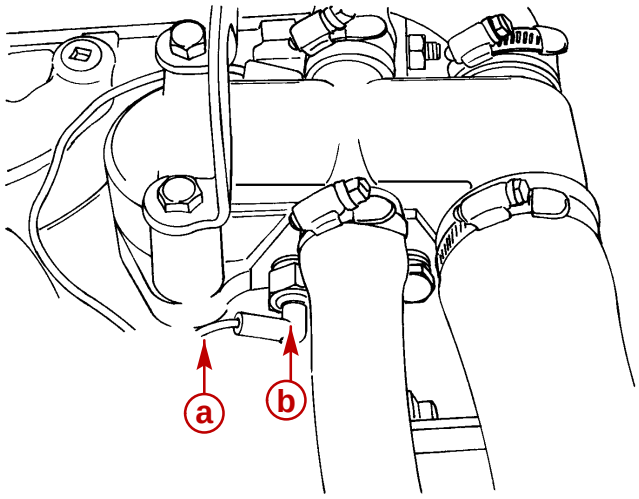
Switch Identification

a - 48952 Switch With Red Mylar Sleeve
b - 87-86080 Switch With Black Mylar Sleeve

6. Turn heat source off. Allow sand to cool. Note thermometer reading to ensure switch “opens” up at specified temperature.
7. Replace switch if switch fails to either open or close within the specified temperatures.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of water temperature switch.
2. Install switch in thermostat housing and tighten securely.
3. Connect TAN wire and coat connection with Liquid Neoprene.



72611

Seawater Cooled Model Shown, Closed Cooled Similar Location

a - TAN Wire
b - Water Temperature Switch

4. If equipped with closed cooling, refill closed cooling system with approved coolant. Refer to SECTION 6.

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ELECTRICAL SYSTEMS

Section 4E - Wiring Diagrams

Table of Contents

Wiring Colors for Mercury MerCruiser . .	4E-2
MCM Gasoline Engine Wiring Diagrams	4E-4
Starting and Charging Harness	4E-4
Fuel and Ignition System Harnesses	4E-16
Quicksilver Instrumentation	4E-22
Dual Station Wiring	4E-24

4 E

Wiring Colors for Mercury MerCruiser

Note: *Color codes listed below DO NOT apply to fuel injection system harnesses.*

Color Code And Abbreviations	Where Used
BLACK (BLK)	All Grounds
BROWN (BLU)	Reference Electrode - MerCathode
ORANGE (ORN)	Anode Electrode - MerCathode
LT. BLUE/WHITE (LT BLU/WHT)	Trim - “Up” Switch
GRAY (GRY)	Tachometer Signal
GREEN/WHITE (GRN/WHT)	Trim - “Down” Switch
TAN (TAN)	Water Temperature Sender to Gauge
LIGHT BLUE (LIT BLU)	Oil Pressure Sender to Gauge
PINK (PNK)	Fuel Gauge Sender to Gauge
BROWN/WHITE (BRN/WHT)	Trim Sender to Trim Gauge
PURPLE/WHITE (PUR/WHT)	Trim - “Trailer” Switch
RED (RED)	Unprotected Wires from Battery
RED/PURPLE (RED/PUR)	Protected (Fused) Wires from Battery
RED/PURPLE (RED/PUR)	Protected (+12V) to Trim Panel
ORANGE (ORN)	Alternator Output
PURPLE/YELLOW (PUR/YEL)	Ballast Bypass
PURPLE (PUR)	Ignition Switch (+12V)
YELLOW/RED (YEL/RED)	Starter Switch to Starter Solenoid to Neutral Start Switch

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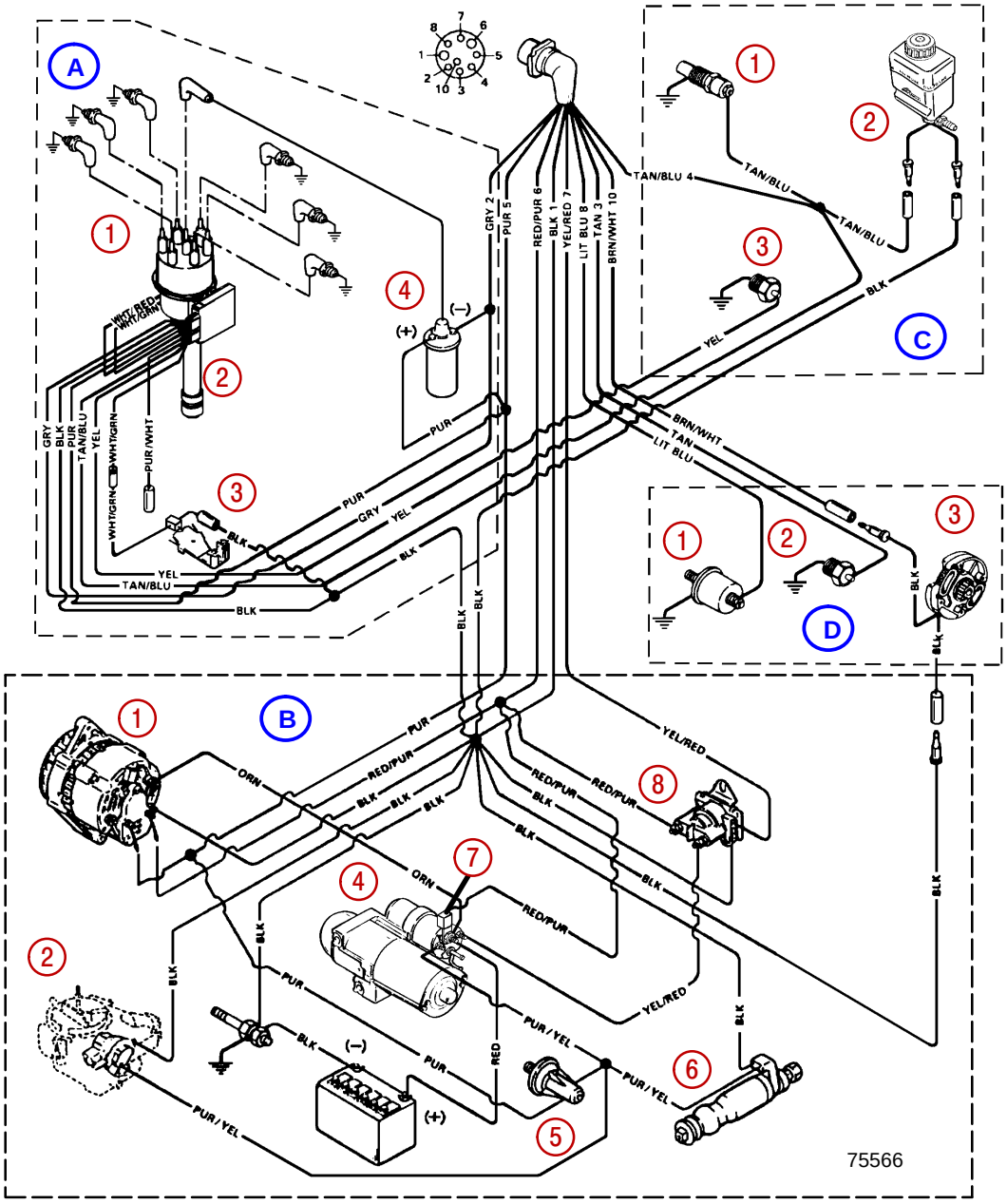
MCM Gasoline Engine Wiring Diagrams

Starting and Charging Harness

MCM 4.3L ALPHA ENGINES



A - Ignition Components

1 - Distributor
2 - Timing Lead
3 - Shift Cutout Switch
4 - Ignition Coil

B - Starting, Charging and Choke Components

1 - Alternator
2 - Electric Choke
3 - Ground Stud
4 - Starter Motor
5 - Oil Pressure Switch
6 - Fuel Pump
7 - Fuse
8 - Starter Slave Solenoid

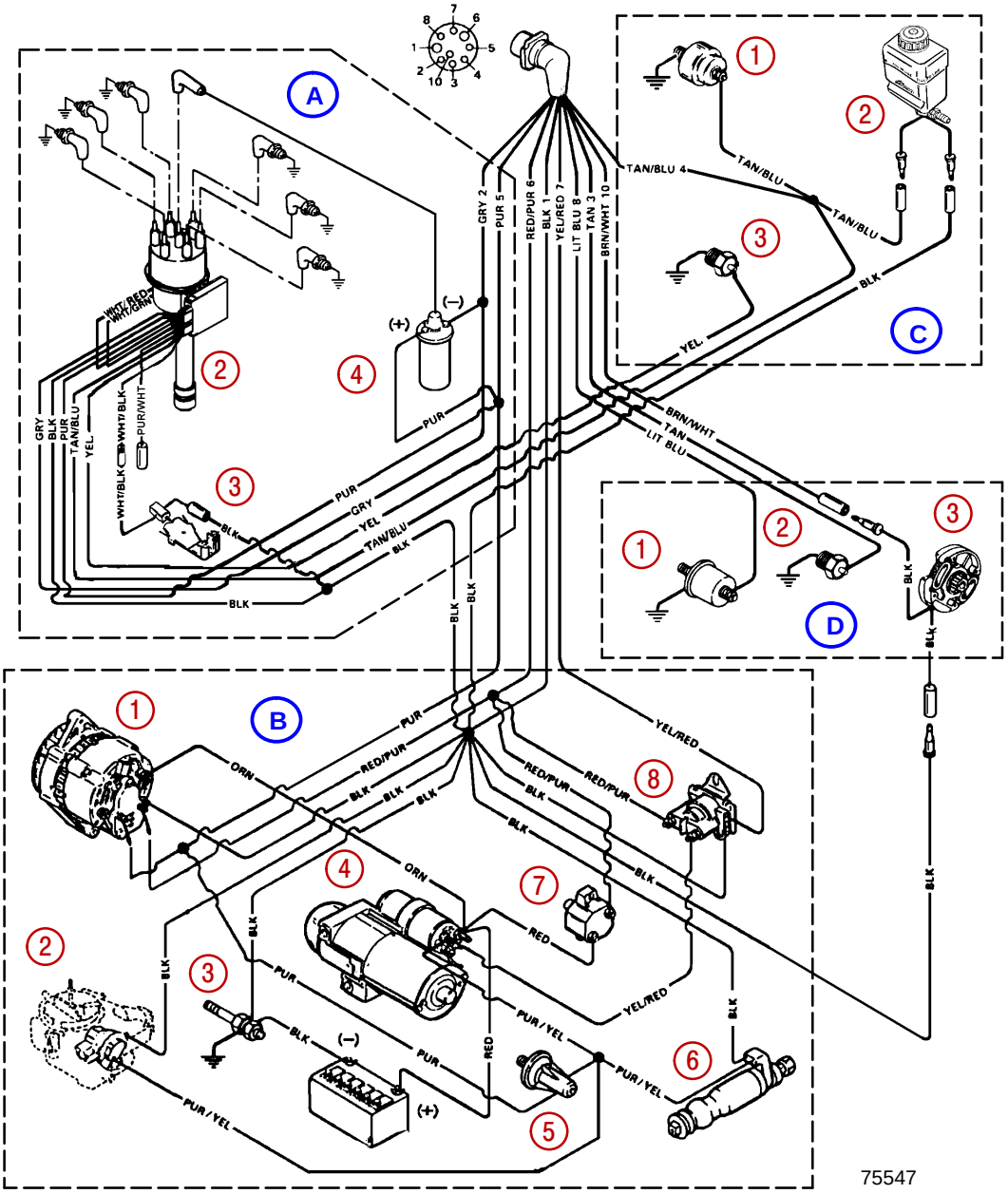
C - Audio Warning Components

1 - Oil Pressure Switch
2 - Drive Unit Gear Lube Monitor
3 - Water Temperature Sender

D - Instrumentation Components

1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

MCM 4.3LH ALPHA ENGINES



A - Ignition Components

1 - Distributor
2 - Timing Lead
3 - Shift Cutout Switch
4 - Ignition Coil

B - Starting, Charging and Choke Components

1 - Alternator
2 - Electric Choke
3 - Ground Stud
4 - Starter Motor
5 - Oil Pressure Switch
6 - Fuel Pump
7 - Circuit Breaker
8 - Starter Slave Solenoid

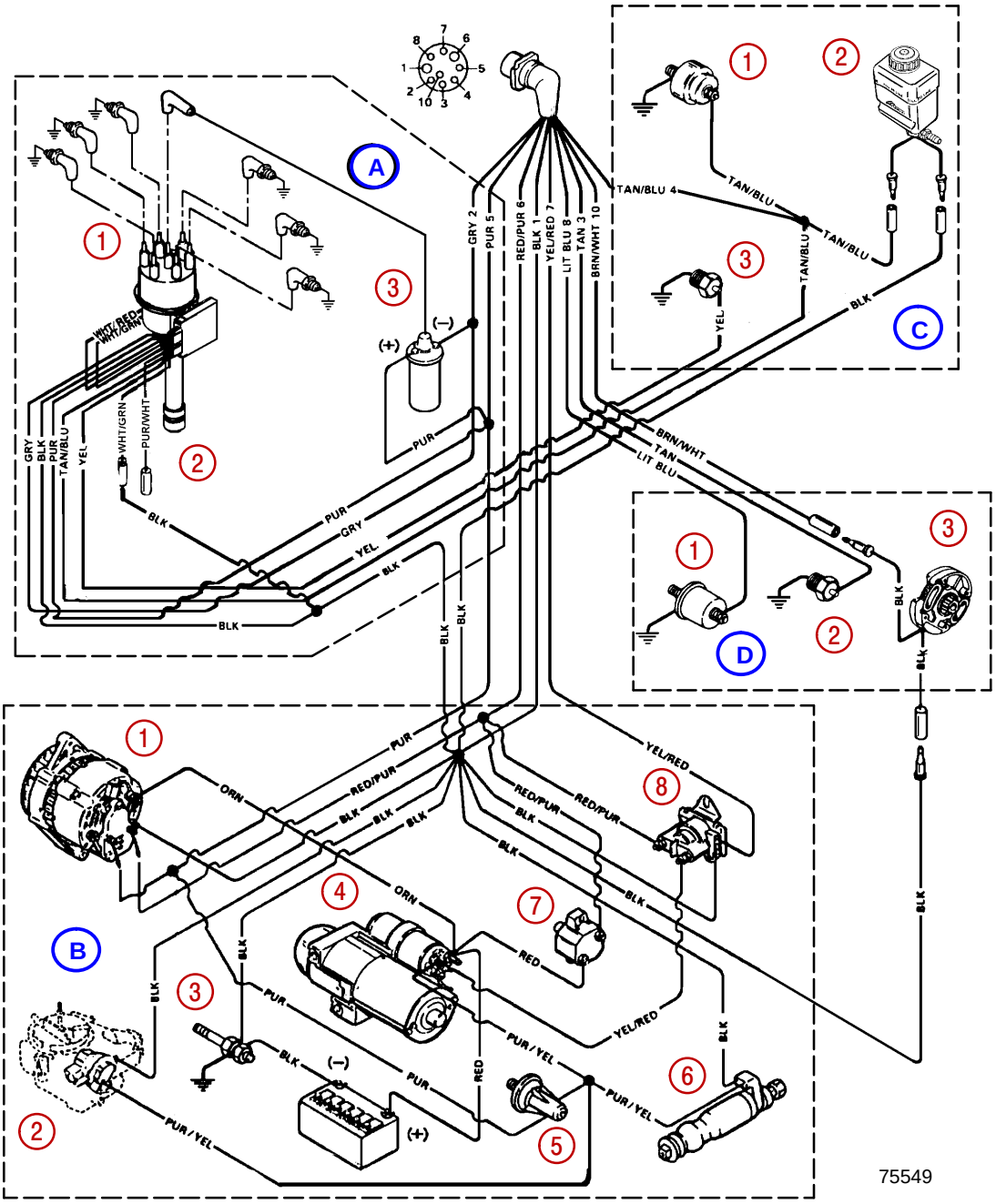
C - Audio Warning Components

1 - Oil Pressure Switch
2 - Drive Unit Gear Lube Monitor
3 - Water Temperature Sender

D - Instrumentation Components

1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

MCM 4.3L AND 4.3LH BRAVO MODELS



A - Ignition Components

1 - Distributor
2 - Timing Lead
3 - Ignition Coil

B - Starting, Charging and Choke Components

1 - Alternator
2 - Electric Choke
3 - Ground Stud
4 - Starter Motor
5 - Oil Pressure Switch
6 - Fuel Pump
7 - Circuit Breaker
8 - Starter Slave Solenoid

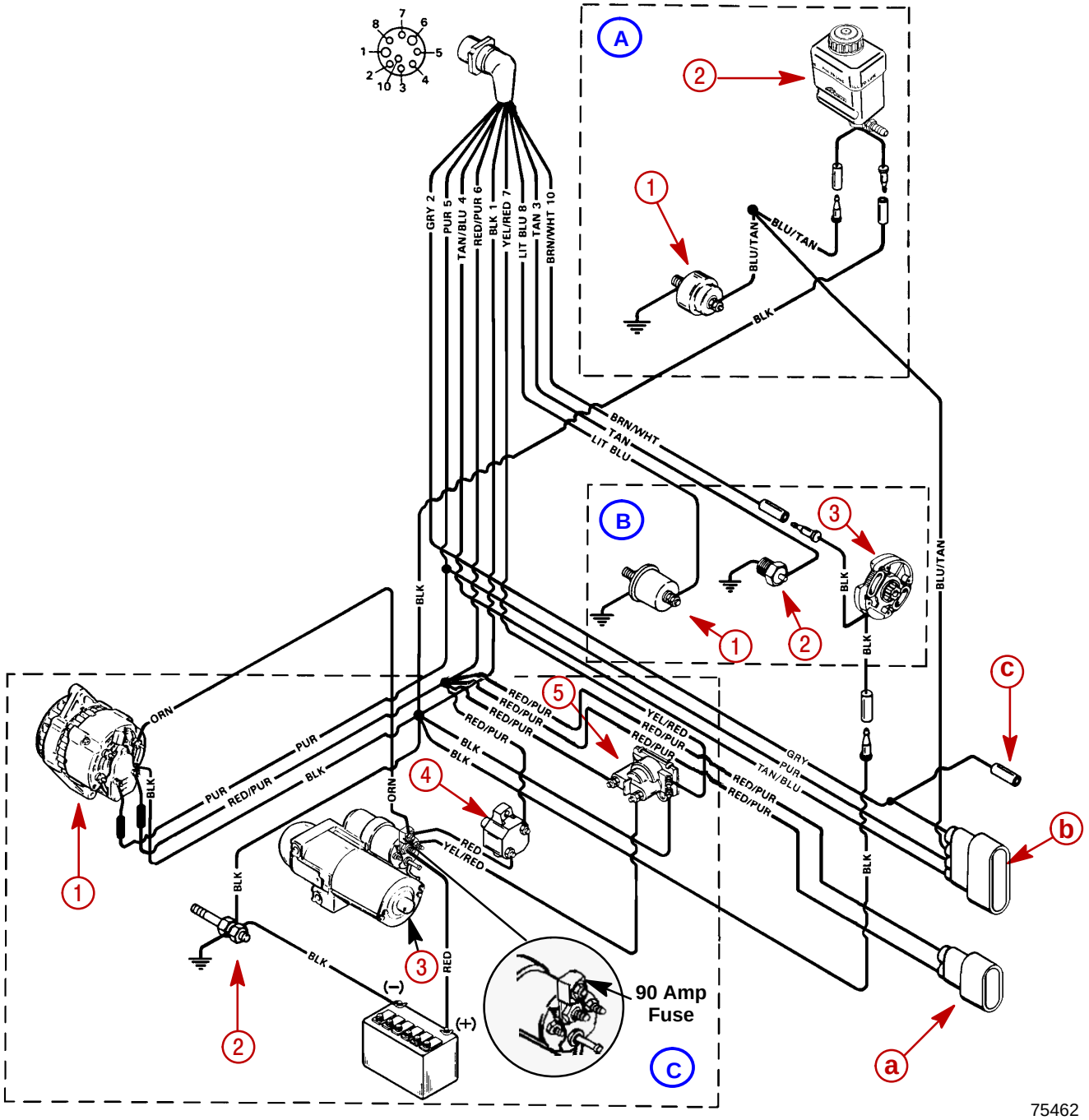
C - Audio Warning Components

1 - Oil Pressure Switch
2 - Drive Unit Gear Lube Monitor
3 - Water Temperature Sender

D - Instrumentation Components

1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

MEFI 1 MCM 4.3L EFI ALPHA MODELS



A - Audio Warning Components

1 - Oil Pressure Switch
2 - Drive Unit Oil Level

B - Instrumentation Components

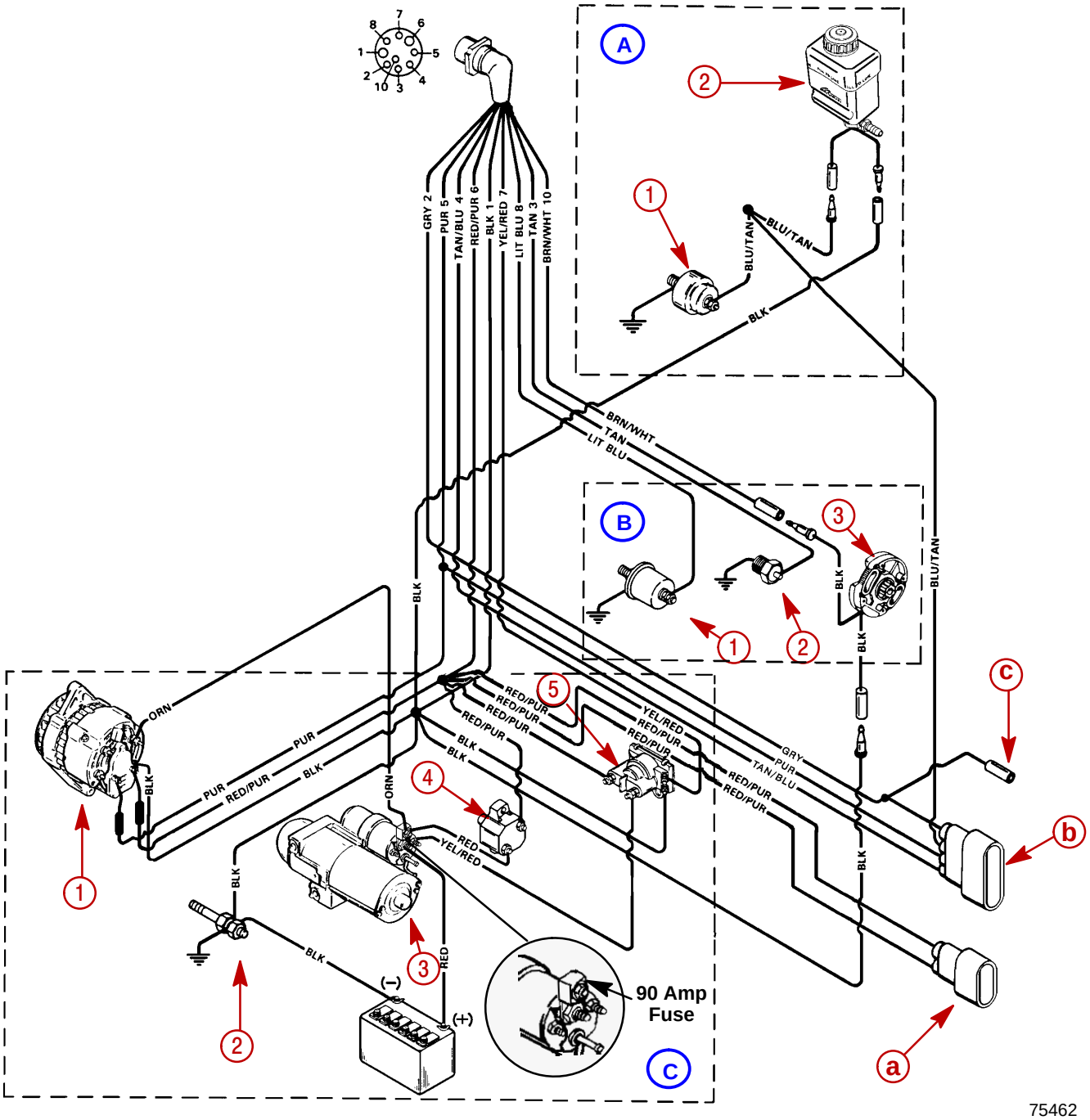
1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

C - Charging and Starting Components

1 - Alternator
2 - Ground Stud
3 - Starter
4 - Circuit Breaker
5 - Starter Slave Solenoid

a - Positive Power Wire To EFI System Harness
b - Harness Connector To EFI System Harness
c - Auxiliary Tachometer Lead

MEFI 1 MCM 4.3L EFI BRAVO MODELS



A - Audio Warning Components

1 - Oil Pressure Switch
2 - Drive Unit Oil Level

B - Instrumentation Components

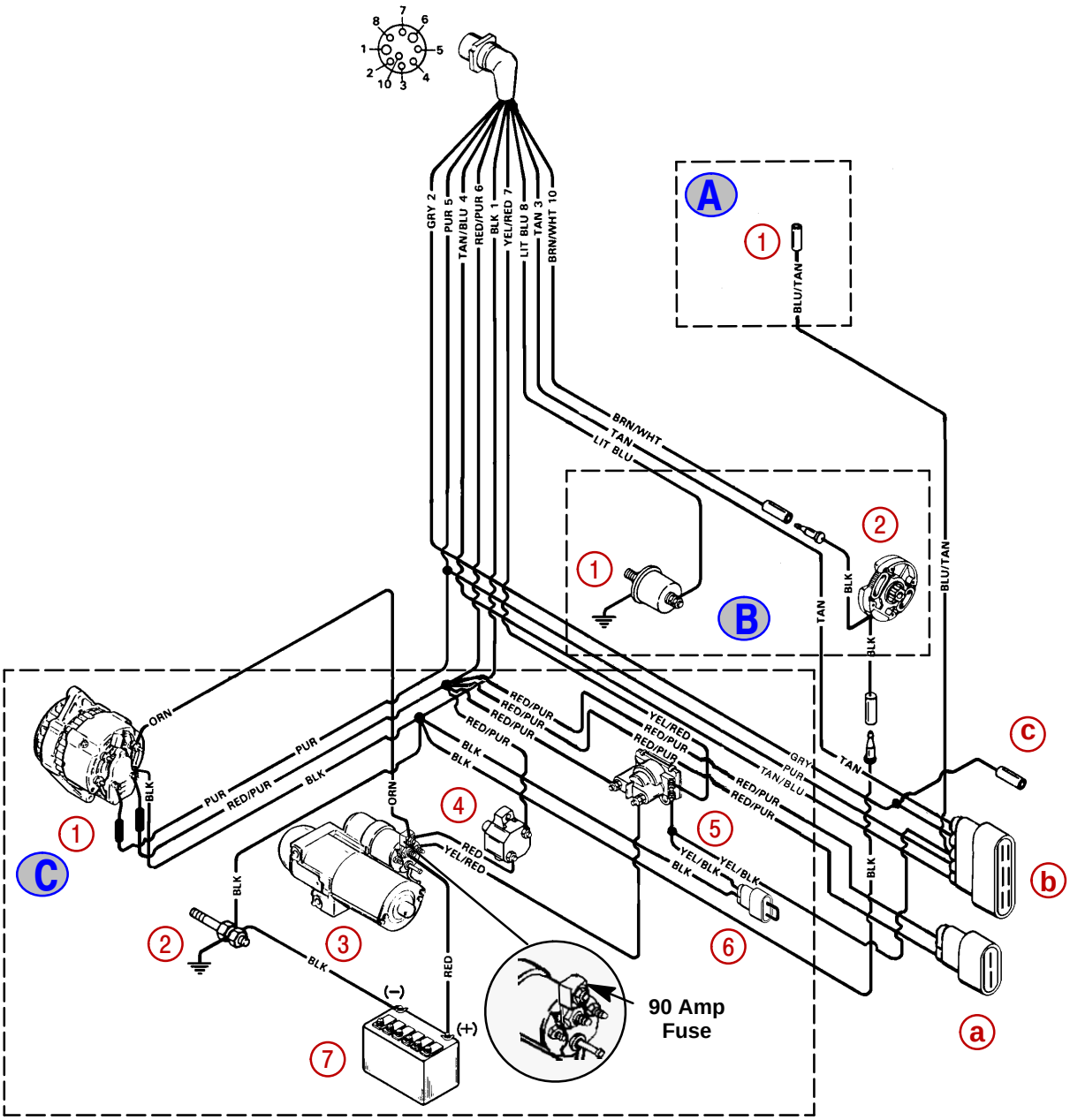
1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

C - Charging and Starting Components

1 - Alternator
2 - Ground Stud
3 - Starter
4 - Circuit Breaker
5 - Starter Slave Solenoid

a - Positive Power Wire To EFI System Harness
b - Harness Connector To EFI System Harness
c - Auxiliary Tachometer Lead

MEFI 3 MCM 4.3L EFI ENGINES



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A - Audio Warning Components

1 - Oil Pressure Switch

B - Instrumentation Components

1 - Oil Pressure Sender
2 - Trim Sender

C - Charging and Starting Components

1 - Alternator
2 - Ground Stud
3 - Starter
4 - Circuit Breaker
5 - Starter Slave Solenoid
6 - Jumper Wire Connection
7 - Battery

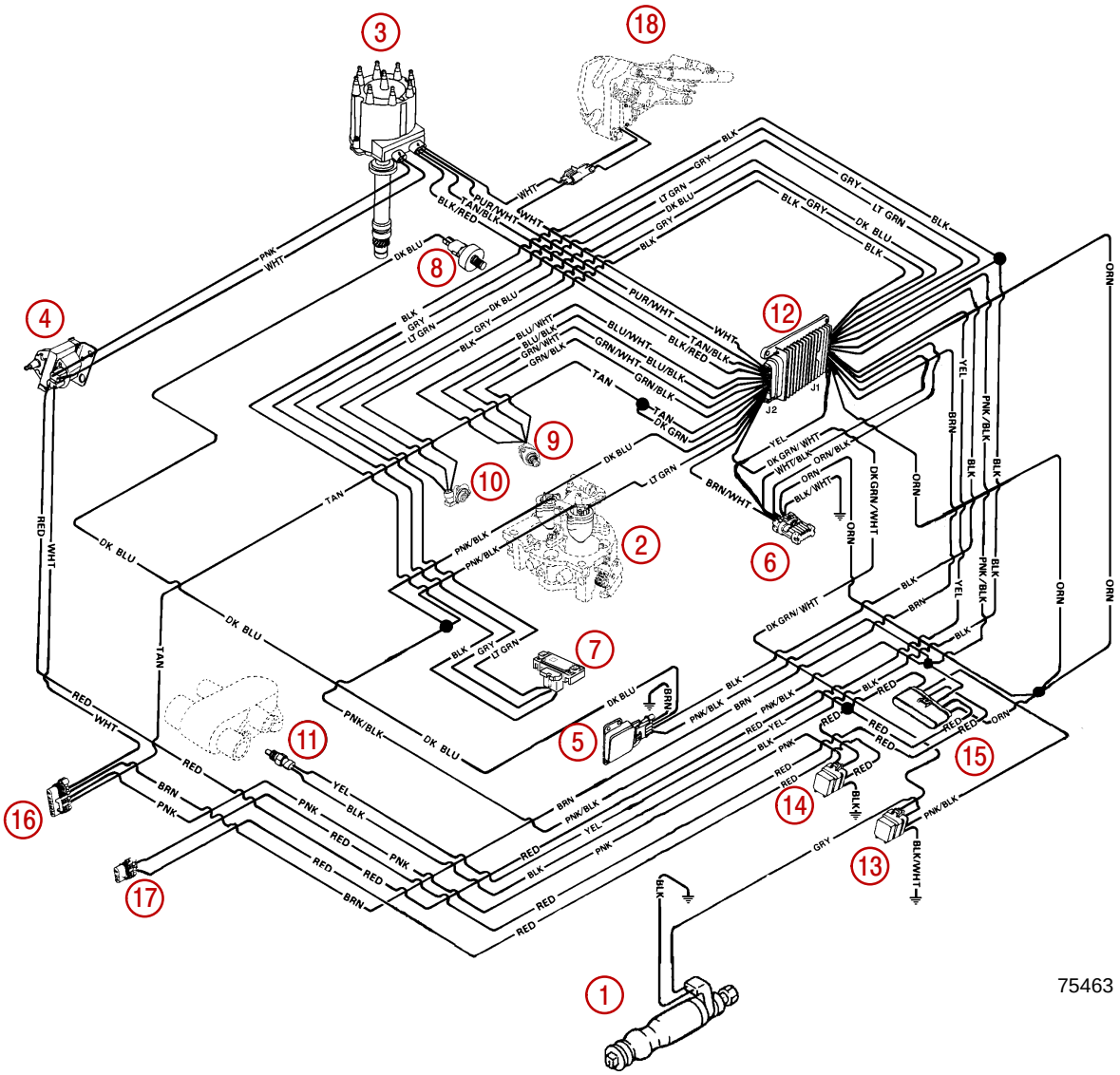
a - Positive Power Wire To EFI System Harness
b - Harness Connector To EFI System Harness
c - Auxiliary Tachometer Lead

Fuel and Ignition System Harnesses

MEFI 1 MCM 4.3L EFI ALPHA

Note: *All BLACK wires with a ground symbol are interconnected within the EFI system harness.*

Note: *Component position and orientation shown is arranged for visual clarity and ease of circuit identification.*



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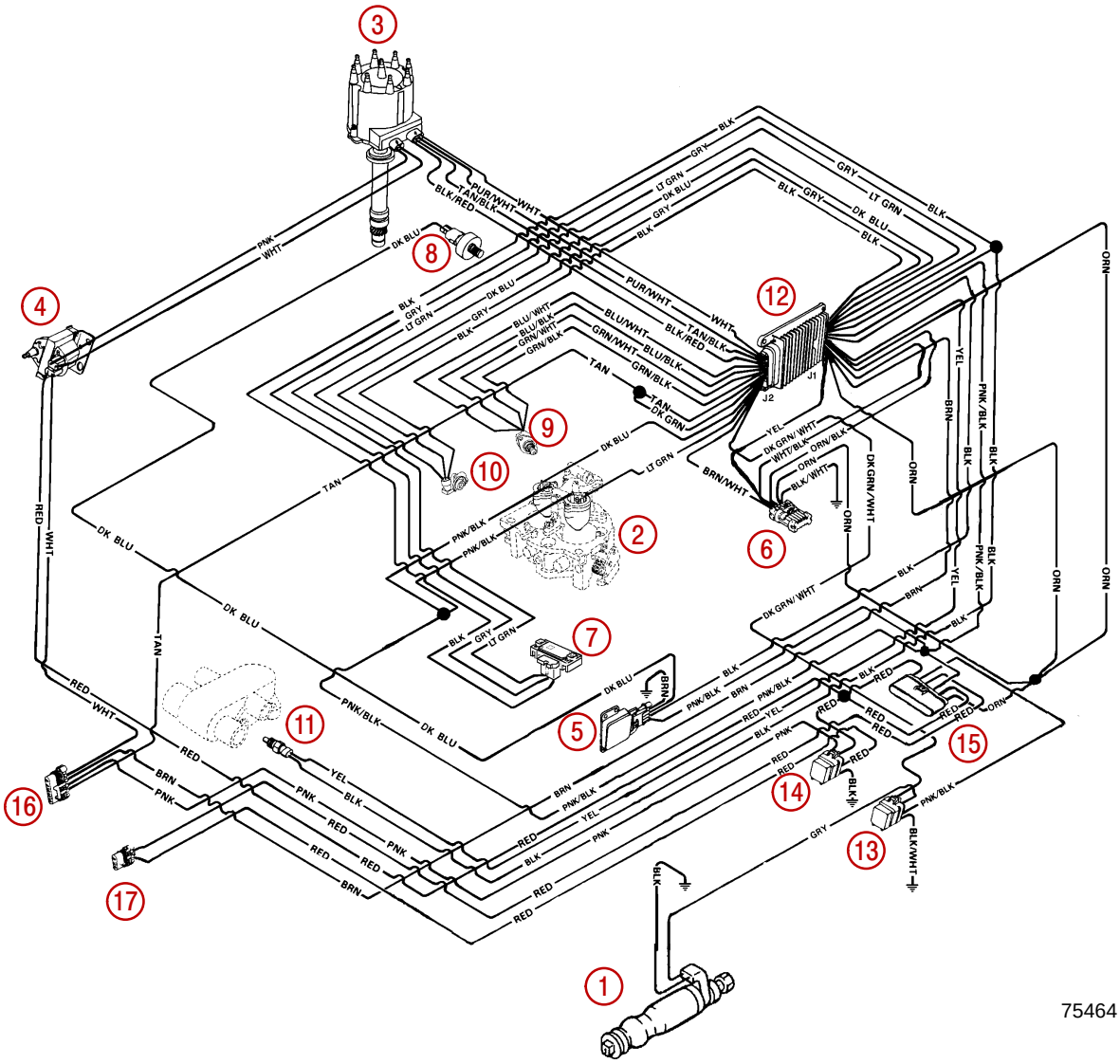
1 - Fuel Pump
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Electronic Spark Control (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10 - Throttle Position (TP) Sensor
11 - Engine Coolant Temperature (ECT) Sensor
12 - Electronic Control Module (ECM)
13 - Fuel Pump Relay
14 - Ignition/System Relay
15 - Fuse (15 Amp) Fuel Pump
Fuse (15 Amp) ECM/DLC/Battery
Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
16 - Harness Connector To Starting/Charging Harness
17 - Positive (+) Power Wire To Engine Circuit Breaker
18 - Shift Cutout Switch

MEFI 1 MCM 4.3L EFI BRAVO MODELS

Note: *All BLACK wires with a ground symbol are interconnected within the EFI system harness.*

Note: *Component position and orientation shown is arranged for visual clarity and ease of circuit identification.*



1 - Fuel Pump
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Electronic Spark Control (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10 - Throttle Position (TP) Sensor
11 - Engine Coolant Temperature (ECT) Sensor
12 - Electronic Control Module (ECM)
13 - Fuel Pump Relay
14 - Ignition/System Relay
15 - Fuse (15 Amp) Fuel Pump
Fuse (15 Amp) ECM/DLC/Battery
Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
16 - Harness Connector To Starting/Charging Harness
17 - Positive (+) Power Wire To Engine Circuit Breaker

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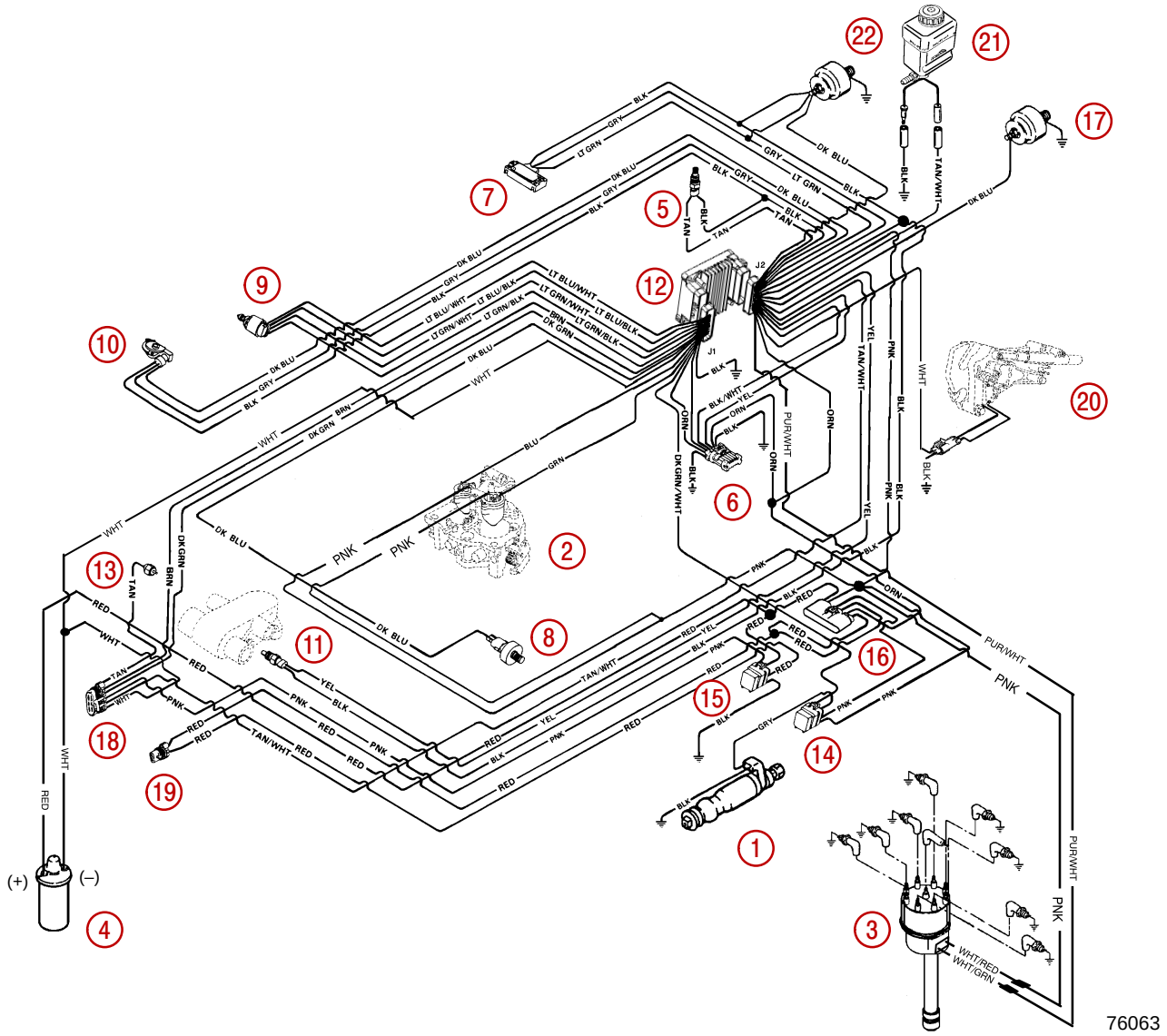
MEFI 3 4.3L EFI ENGINES

Note: *All BLACK wires with a ground symbol are interconnected within the EFI system harness.*

Note: *Component position and orientation shown is arranged for visual clarity and ease of circuit identification.*

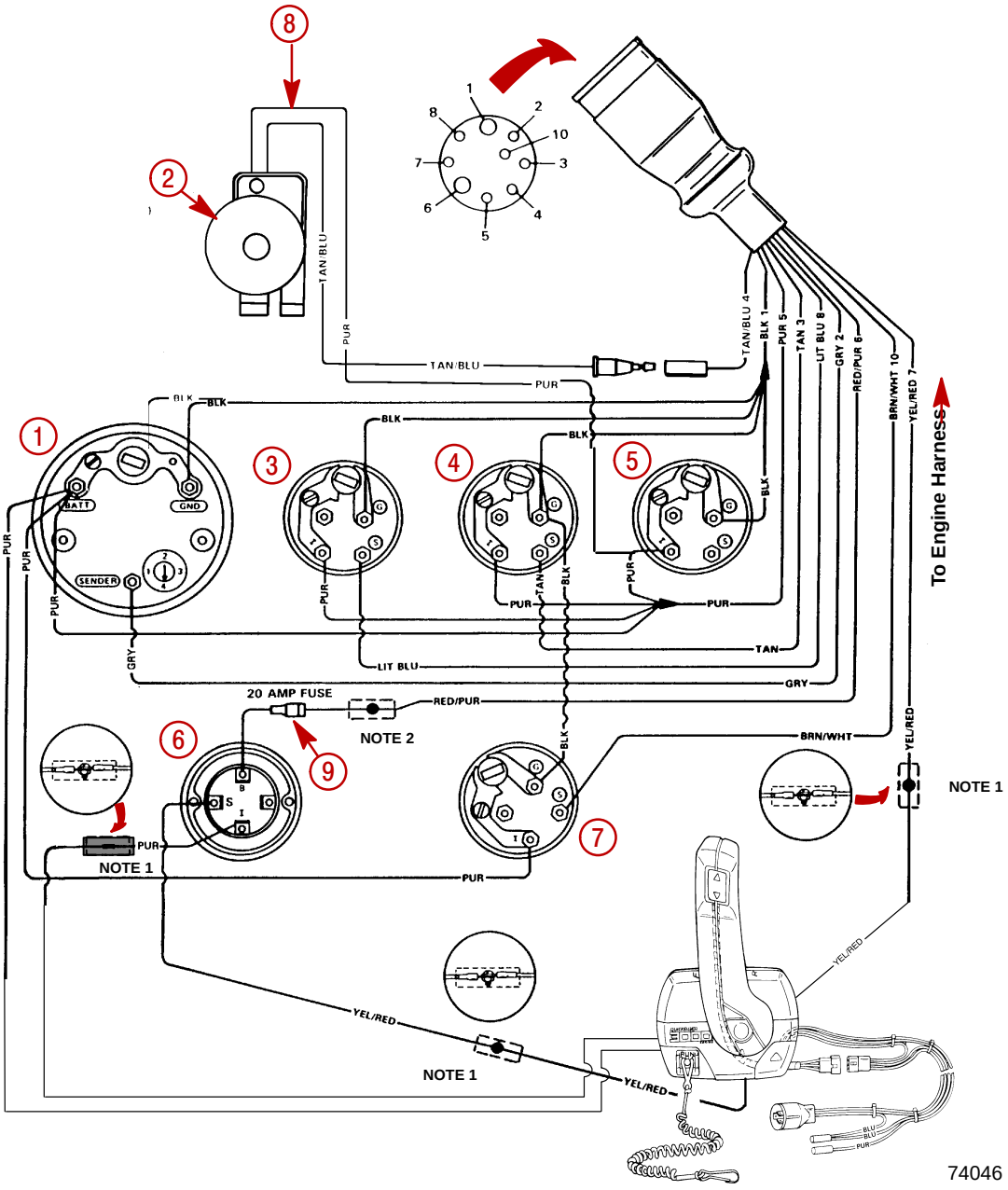


1 - Fuel Pump
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Manifold Air Temperature (MAT) Sensor
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10 - Throttle Position (TP) Sensor
11 - Engine Coolant Temperature (ECT) Sensor
12 - Electronic Control Module (ECM)
13 - Water Temperature Sender
14 - Fuel Pump Relay
15 - Ignition/System Relay
16 - Fuses (15 Amp) Fuel Pump, (15 Amp) ECM/DLC/Battery, (10 Amp) ECM/Injector/Ignition/Knock Module
17 - Oil Pressure Sensor
18 - Harness Connector To Starting/Charging Harness
19 - Positive (+) Power Wire To Engine Circuit Breaker
20 - Shift Plate (Alpha Models)
21 - Gear Lube Monitor
22 - Fuel Pressure Switch

Quicksilver Instrumentation

Note: Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

Note: Power for a second fused accessory panel may be taken from this connection. Load **MUST NOT** exceed 35-40 amps. Panel ground wire **MUST BE** connected to instrument terminal that has an 8 gauge BLACK (ground) harness wire connected to it.



1 - Tachometer
2 - Audio Warning Buzzer (if Equipped)
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - Ignition Switch
7 - Trim Indicator
8 - To 12 Volt Source (PURPLE wire connection)
9 - 20 Ampere Fuse

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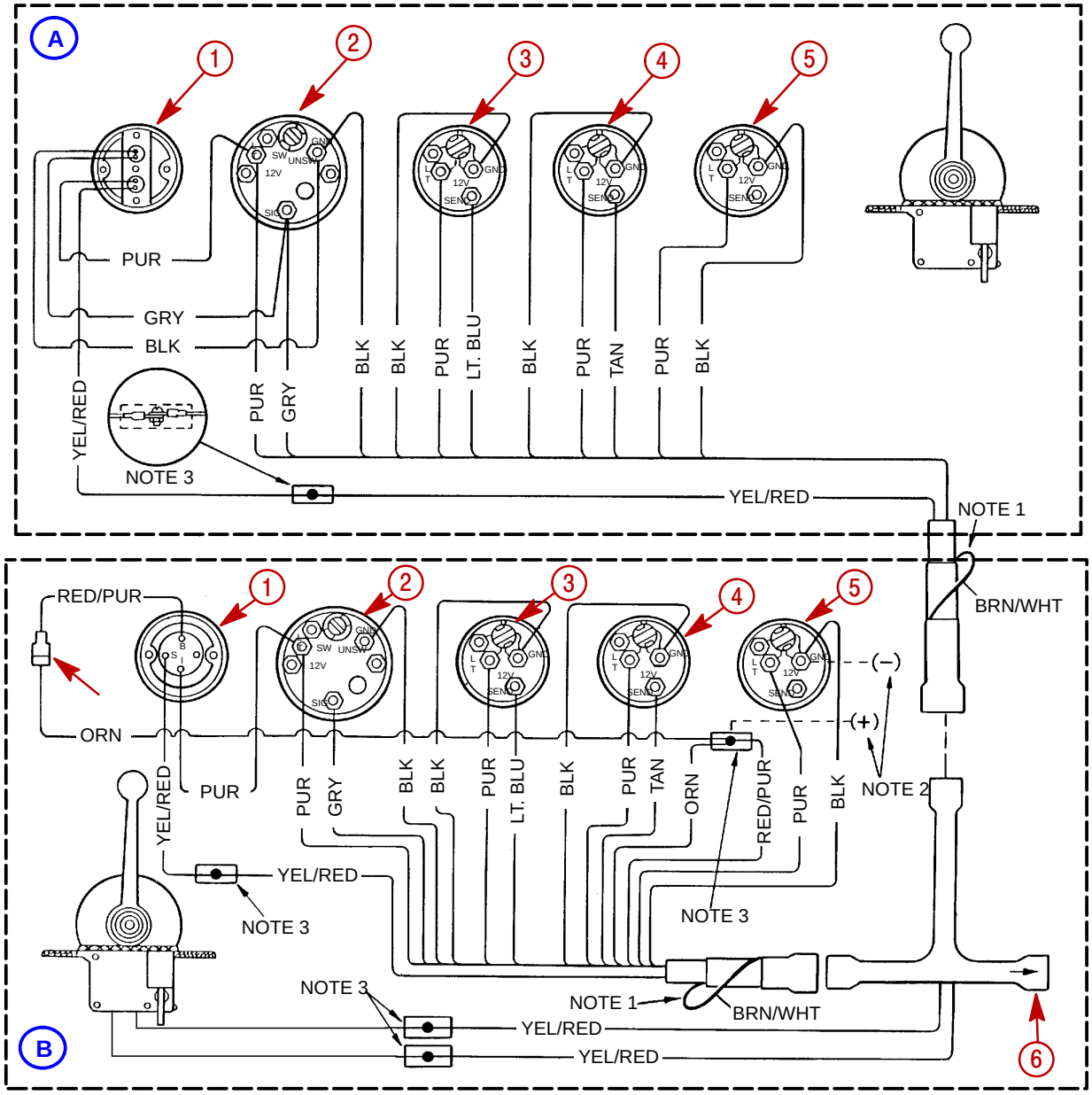
Dual Station Wiring (Using a Neutral Safety Switch in Only One Remote Control)



Note: *BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes).*

Note: *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station* ***MUST NOT*** *exceed 35 amperes.*

Note: *Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.*

Index

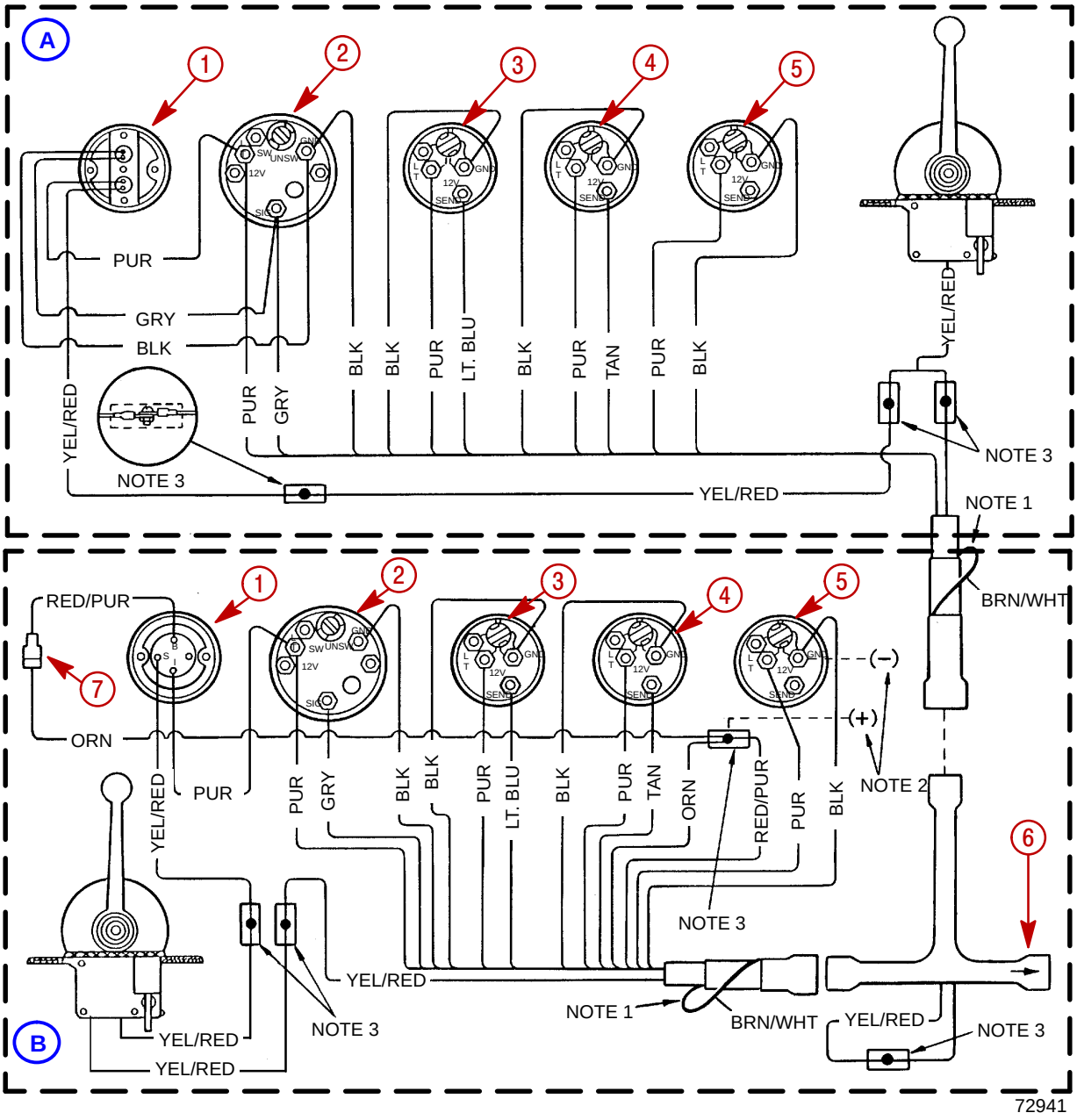
A - Secondary Station

1 - Stop -Start Panel
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station

1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

Dual Station Wiring (Using A Neutral Safety Switch In Both Remote Controls)



Note: *BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes).*

Note: *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station* ***MUST NOT*** *exceed 35 amperes.*

Note: *Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.*

A - Secondary Station

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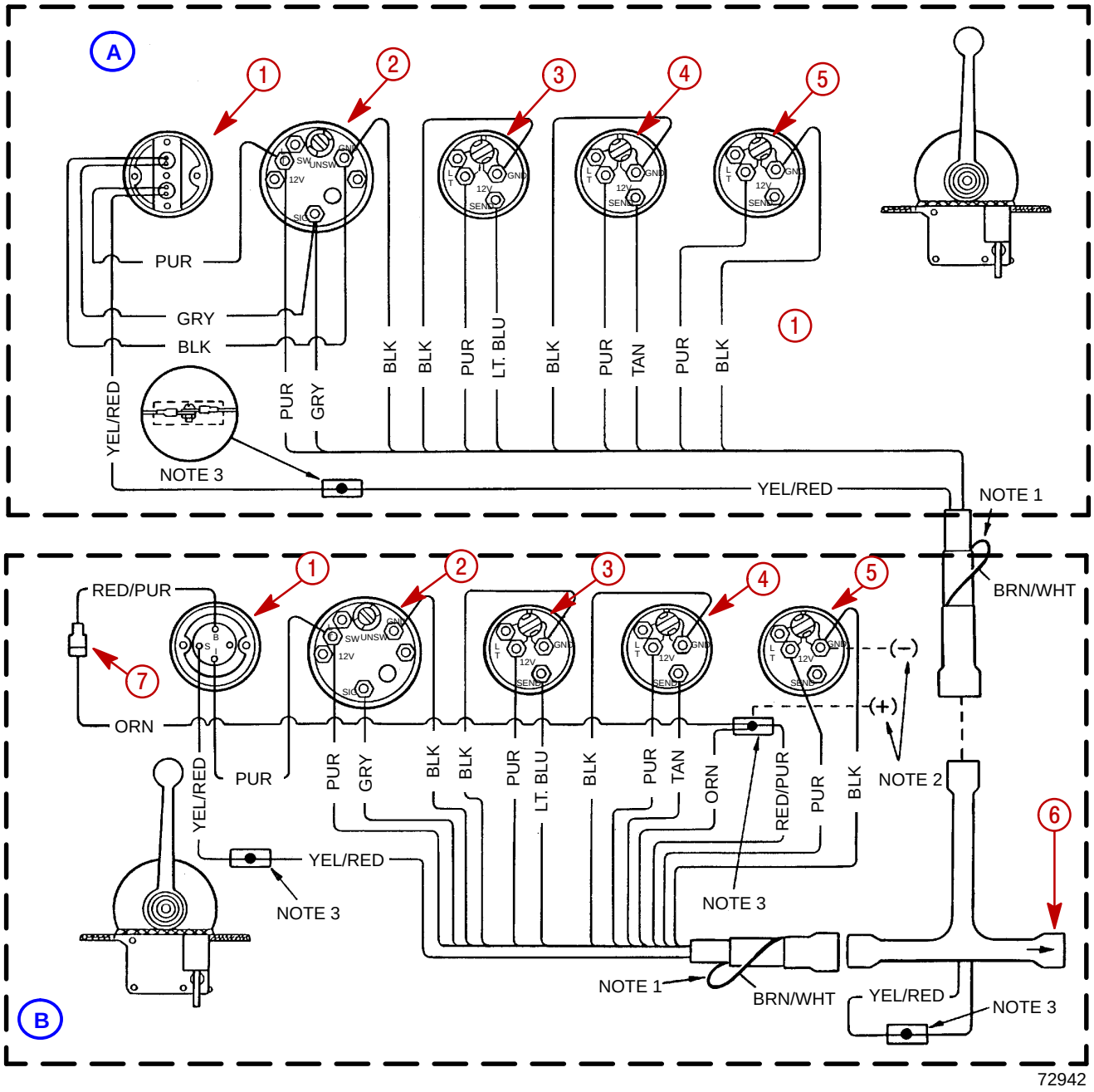
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station

1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

Dual Station Wiring (Using a Neutral Safety Switch in Engine Wiring Harness)



Note: *BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes).*

Note: *An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station* ***MUST NOT*** *exceed 35 amperes.*

Note: *Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.*

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A - Secondary Station

1 - Stop -Start Panel
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5 - Battery Meter

B - Primary Station

1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

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FUEL SYSTEM

Section 5A - Fuel Delivery System For Carbureted Engines

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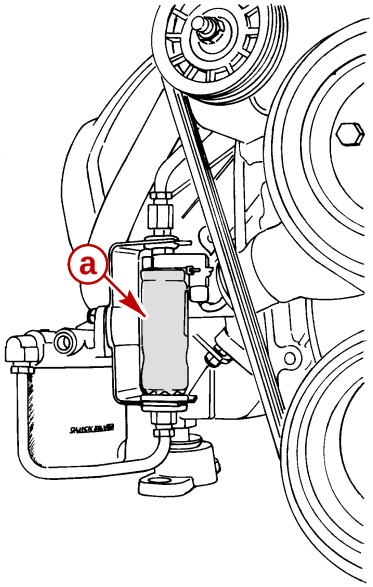
Replacement Parts Warning	5A-2	Recommendations	5A-4
Specifications	5A-2	Fuel System Components	5A-6
Torque Specifications	5A-2	Water Separating Fuel Filter	5A-7
Tools	5A-3	Replacement	5A-8
Lubricants / Sealants / Adhesives	5A-3	Vent Hose Routing	5A-8
Precautions	5A-3	Carbureted Models	5A-8
Fuel Supply Connections	5A-3		

5 A

Identification



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a - Fuel Pump

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Specifications

Description	Specification
Pump Pressure	3-7 PSI (21-48 kPa)

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Fuel Lines		18	24
Fuel Fittings Into Adapter		See Note	

NOTE: *Refer To "Fuel Supply Connections" Warning following this chart.*

Tools

Description	Part Number
Fuel Pressure Connector (Carburetor)	91-18078
Fuel Pressure Gauge	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
#592 Loctite Pipe Sealant with Teflon	Obtain Locally

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure that no fuel leaks exist before closing engine hatch.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT Overtighten.**
- **Install fuel line. To prevent overtightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

Index

Fuel Delivery System

Recommendations

⚠ WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing fuel delivery system

GENERAL

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance that you have received from the tank manufacturer.

Only a few points related to function and safety are listed here. Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines:

- All connections should be on the upper side of the tank.
- The drain plug at the lowest point on the tank serves to permit the removal of water and sediment.
- The filler pipe outer diameter should be at least 2 in. (51 mm).
- The tank breather pipe must have an inner diameter of at least 1/2 in. (13mm) and must be fitted with a swan neck to prevent water from entering the tank.

It is recommended that the exact route and length of the fuel lines be established at the first installation of the engine to prevent problems later in connecting them to the engine.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, applying to all engines unless otherwise stated, must be considered [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

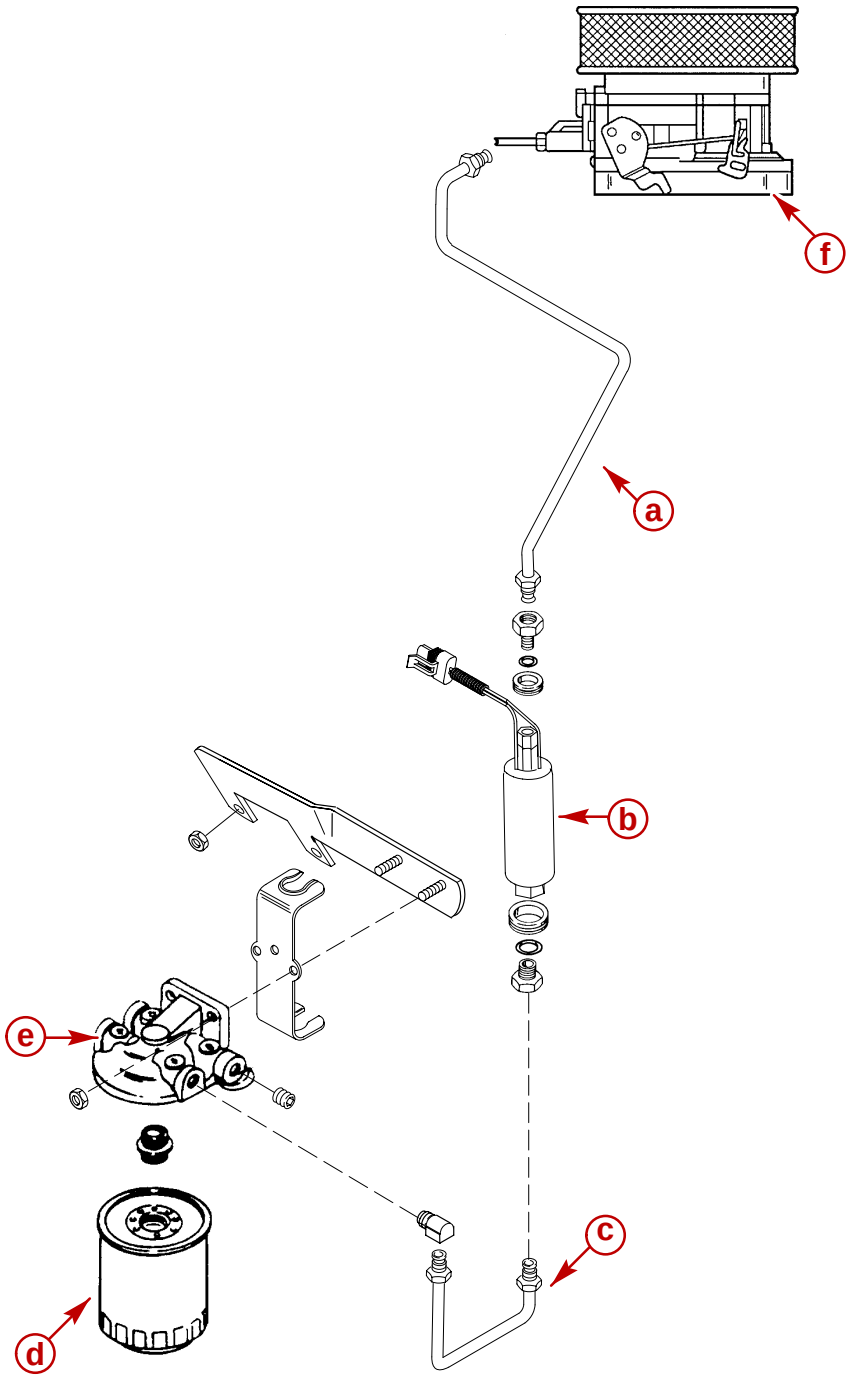
1. Fuel tank should be mounted below carburetor level (if possible) or gravity feed may cause carburetor fuel inlet needle to unseat and flooding may result.
2. Fuel pickup should be at least 1 in. (25mm) from the bottom of fuel tank to prevent picking up impurities.
3. Fuel lines used must be Coast Guard approved (USCG Type A1).

Diameter of fittings and lines must not be smaller than 5/16 in. (8 mm) inside diameter (I.D.)

4. **On Multi-Engine Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must not be smaller than 1/2 in. (13mm) I.D.

5. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
6. Fuel line(s) should be installed free of stress and firmly secured to prevent vibration and/or chafing.
7. Sharp bends in fuel lines should be avoided.
8. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Fuel System Components



a - Fuel Line to Carburetor
b - Fuel Pump
c - Fuel Line to Fuel Pump
d - Water Separating Fuel Filter
e - Fuel Filter Base
f - Carburetor

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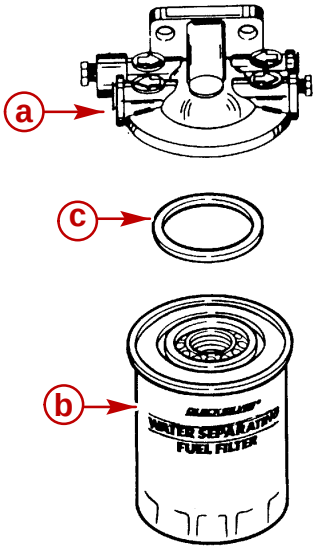
Water Separating Fuel Filter

The water separating fuel filter is standard on all engines.

The fuel filter consists of the fuel filter base and filter element.



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a - Fuel Filter Mounting Bracket
b - Filter Element
c - Sealing Ring

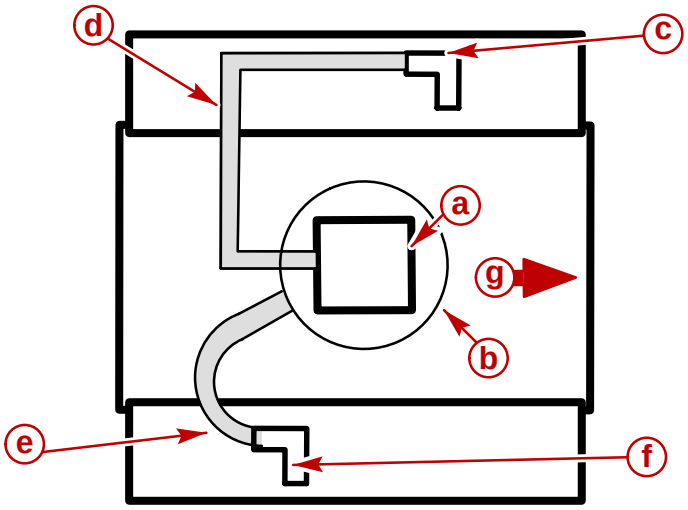
Replacement

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel filter from base. A filter wrench may be needed to loosen element.
3. Lubricate sealing ring of new filter with SAE engine oil.
4. Install new filter, tightening securely by hand.
5. Reconnect battery cables.
6. Make sure water is supplied to cooling system.
7. Start engine.
8. Check for fuel leaks.

Vent Hose Routing

Carbureted Models



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a - Carburetor
b - Flame Arrestor
c - PCV Valve
d - Vent Hose - PCV Valve to Back Of Carburetor
e - Vent Hose - Valve Cover Fitting To Flame Arrestor
f - Valve Cover Fitting
g - Front of Engine

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FUEL SYSTEM

Section 5B - Mercarb® 2 Barrel Carburetor

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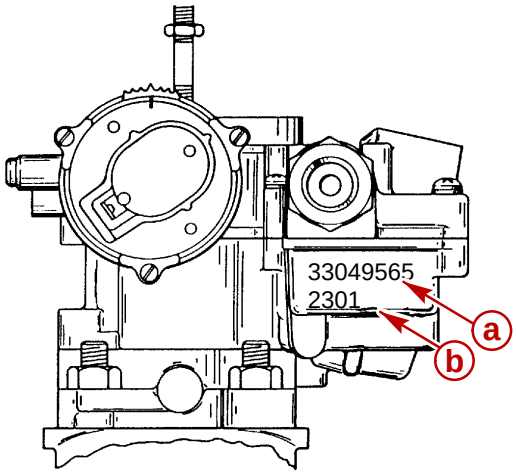
5 B

Identification



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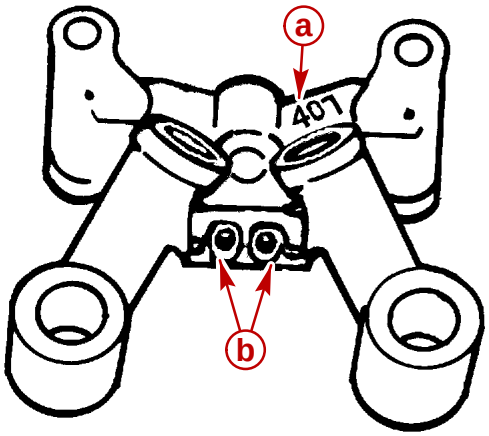
2 Barrel MerCarb Carburetor Part Number Location

a - Part Number
b - Date Code

Date Code Explanation: Example 2301

First Figure is Year:
2 = 1992, 3 = 1993, etc.
Second Figure is Month:
2 = February, 3 = March, etc.
X = October, Y = November, Z = December
Third and Fourth Figures are Day of Month:
01 = First day, 02 = Second day, etc.



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Venturi Cluster Identification

a - Identification Number (See Specifications)
b - Accelerator Pump Discharge Holes

Replacement Parts Warning

⚠ WARNING

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Use of replacement electrical, ignition or fuel system components, that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided.

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Torque Specifications

Description	lb-in.	lb-ft	Nm
Carburetor To Manifold		20	27
Fuel Line to Carburetor		18	24
Fuel Inlet Filter Nut		18	24

Specifications

Engine Model	4.3L
Carburetor Type	MerCarb 43mm
Carburetor Number	3310-807764
Float Level	9/16 (14) See Notes
Float Drop	1-3/32 (27) See Notes
Pump Rod (Location)	Middle Hole Of Pump Arm
Choke Setting	2 Marks Right Of Index Mark (Lean)
Choke Unloader	5/64 [.080] (2)
Idle Mixture Screw	1-1/4 Turns Out
Float Weight	9 grams Maximum
Main Jet Size	1.55 mm
Power Valve Size	0.74 mm
Venturi Cluster ID Number	472
Accelerator Pump Discharge Hole Size	0.035 (0.9)
Fuel Pump Pressure	3-7 psi (21-48 kPa)

NOTE: *Measurement taken from gasket.*

NOTE: *All measurements are +/– 1/64 in. (0.4 mm)*

Tools

Description	Part Number
Tachometer	91-59339
Universal Carburetor Gauge	91-36392
Float Gram Scale	Obtain Locally

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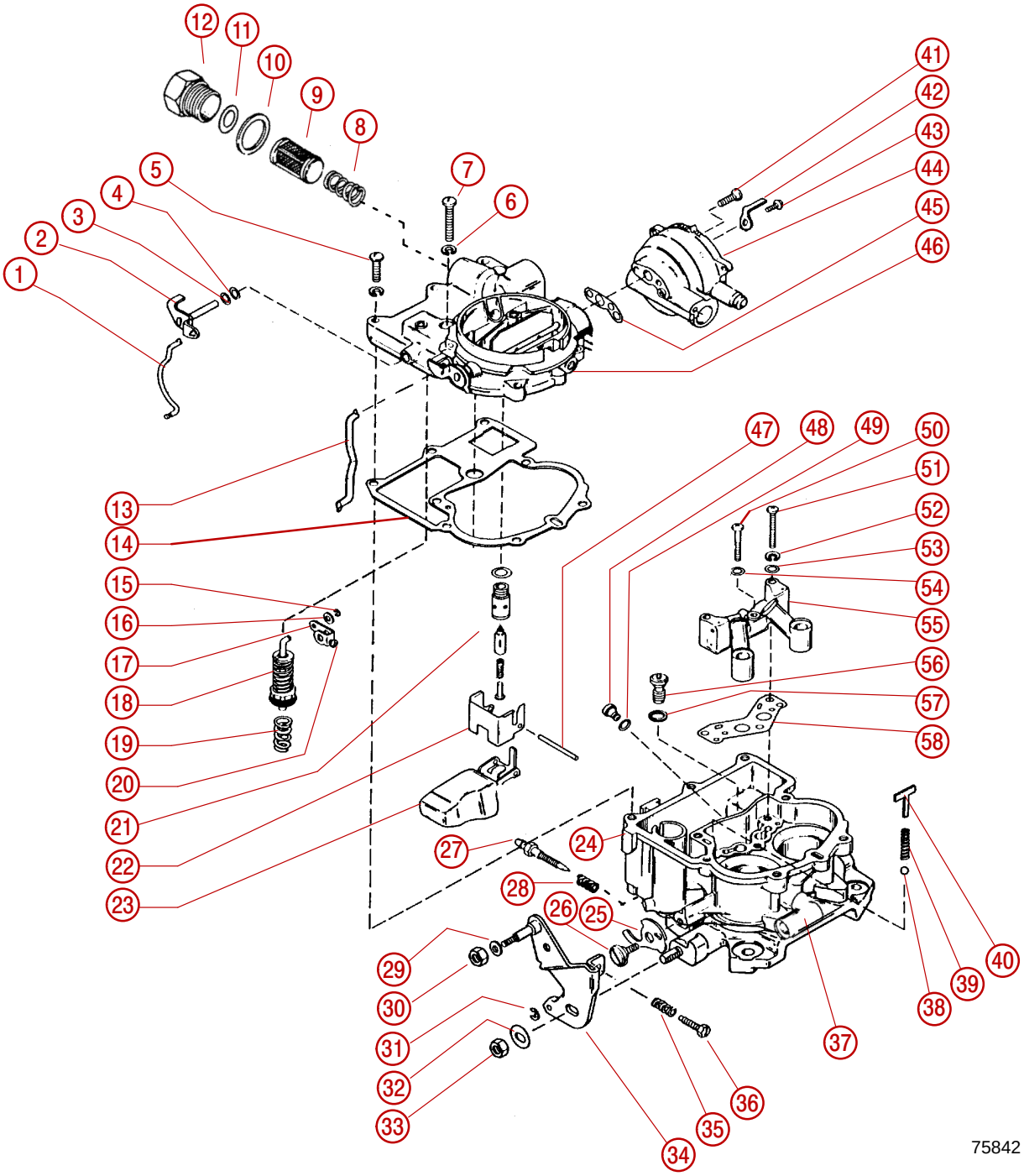
Exploded View



Exploded View Parts List

1 - Rod - Accelerator Pump
2 - Accelerator Pump Shaft and Lever Assembly
3 - Washer (Outer)
4 - Washer (Inner)
5 - Screw
6 - Washer
7 - Screw
8 - Spring
9 - Filter
10 - Gasket
11 - Gasket
12 - Nut-Fuel Inlet
13 - Choke Rod
14 - Gasket
15 - Clip - Retainer
16 - Washer
17 - Pump Shaft and Lever Assembly
18 - Accelerator Pump Assembly
19 - Spring
20 - Screw
21 - Inlet Needle and Seat (Spring Loaded)
22 - Baffle Plate
23 - Float
24 - Carburetor Body
25 - Cam-Idle
26 - Screw
27 - Idle Mixture Adjusting Needle
28 - Spring
29 - Washer
30 - Nut
31 - Clip-Pump Rod
32 - Washer-Locking
33 - Nut
34 - Throttle Lever
35 - Spring
36 - Screw - Idle Speed Adjustment
37 - PCV Tube Connection Fitting
38 - Check Ball
39 - Spring
40 - Retainer
41 - Screw
42 - Lever Assembly
43 - Screw
44 - Choke/Housing
45 - Gasket
46 - Air Horn
47 - Pin
48 - Screw
49 - Gasket
50 - Screw
51 - Screw
52 - Lock Washer
53 - Flat Washer
54 - Gasket
55 - Venturi Cluster
56 - Power Valve Assembly
57 - Gasket
58 - Gasket

Important Service Information

High Altitude Re-Jetting

Engine flooding problems, at idle rpm, are generally related to the altitude (above sea level) at which they are operated. If engine is running too rich at higher elevation, order a smaller jet from the chart. A jet stamped “165” is a 1.65 mm jet.

Models	Carburetor Part Number	5000 ft. (1525 m) and Below	5000-9000 ft. (1525-2745 m)	9000 ft. (2745 m) and Above
4.3	1389-9565A4	1.65 mm #	1.55 mm	1.50 mm
	1389-9565A_ 3310-806972A__	1.60 mm #	1.50 mm	1.45 mm

JET SIZES

Jet Size	Quicksilver Part Number
1.30	3302-811849
1.35	3302-811850
1.40	3302-811851
1.45	3302-9050
1.50	3302-811852
1.55	3302-811853
1.60	3302-810923
1.65	3302-9058
1.70	3302-9055
1.75	3302-881854
1.80	3302-811855
1.85	3302-811856
1.90	3302-811857

POWER VALVES

Jet Size	Quicksilver Part Number
0.74	3302–9435
0.90	3302–9059

8 Point Carburetor Check List

To ensure that the carburetor is the cause of the problem, make the following checks BEFORE ordering and installing a new carburetor. If questions 1, 2, 3, 5, 6 and 7 are YES and 8 is NO, the carburetor may not be the problem.

1.	Does the choke close completely before starting?	Y	N
2.	Does the choke open completely during engine warm-up?	Y	N
3.	Is idle mixture screw set correctly? (Engines with Thunderbolt V ignition must have module locked in Base Timing Mode).	Y	N
4.	What is the idle mixture screw setting?	____Turn	
5.	Is the engine idle speed rpm correct?	Y	N
6.	Is venturi cluster discharging fuel by 2000 rpm?	Y	N
7.	Is a good stream of fuel being discharged by both discharge holes in venturi cluster when throttle lever is moved repeatedly while the engine is off.	Y	N
8.	Does the engine flood at idle?	Y	N

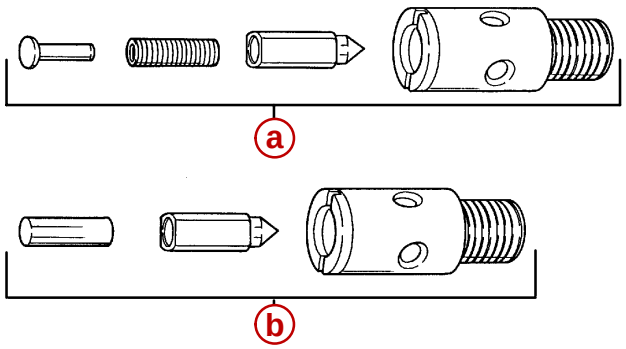
Flooding At Idle RPM

If your engine floods at idle rpm, check the following:

1. Problem in ignition system causing engine to run rough.
2. Idle mixture screw adjusted incorrectly.
3. Bad needle and seat.
4. Incorrect float level or drop.

Needle / Seat Change

MerCarbs are factory equipped with a spring loaded needle. If the preceding steps did not correct your problem, change to the solid type needle.



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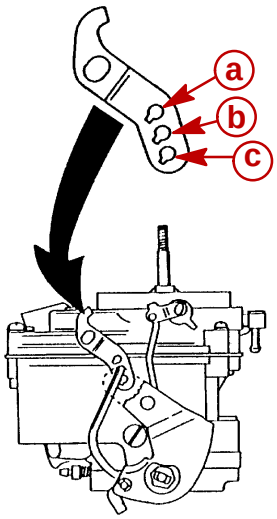
Needle and Seat Assemblies

a - Spring Loaded Type Needle (Kit 3302-9029)
b - Solid Type Needle (Kit 3302-9407)

Adjustable Accelerator Pump Lever

This new 3 hole lever allows you to change the amount of fuel delivered to the engine by the accelerator pump. The hole closest to the lever's shaft will give the same amount of fuel as the single hole lever did. The center hole gives approximately 0.5 cc less fuel and the hole furthest away will give about 1.0 cc less fuel.



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a - Full Accelerator Pump Stroke
b - 0.5 cc Less Fuel per Stroke
c - 1.0 cc Less Fuel per Stroke

When installing the 3-hole lever, remove any metal ball that may have been placed in the accelerator pump well to limit pump travel. Also, ensure that the duration spring on the accelerator pump is stock and hasn't had coils removed. Ensure that the correct venturi cluster is being used.

Description

This MerCarb carburetor is a two bore carburetor that has a separate fuel feed for each venturi. This model is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel / air mixture to the engine.

Maintenance

Flame Arrestor

NOTICE
Refer to “Precautions” in this section, BEFORE proceeding.

REMOVAL

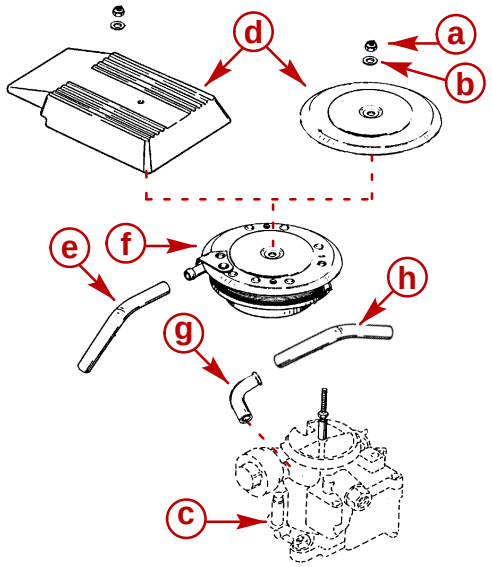
1. Remove nut.
2. Remove sealing washer.
3. Remove flame arrestor cover.
4. Remove crankcase ventilation hose from flame arrestor and starboard rocker arm cover.
5. Remove Positive Crankcase Vent (PCV) hose to carburetor tube and port rocker arm PCV Valve connection.
6. Remove flame arrestor.

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent and blow dry with compressed air.
2. Clean crankcase ventilation and PCV hoses.
3. Inspect hoses for cracks or deterioration and replace if necessary.

INSTALLATION

1. Install flame arrestor.
2. Install crankcase ventilation hose to flame arrestor and starboard rocker arm cover.
3. Install positive crankcase vent (PCV) hose from port rocker arm PCV valve connection to carburetor tube.
4. Install carburetor cover.
5. Install sealing washer and nut. Tighten securely.



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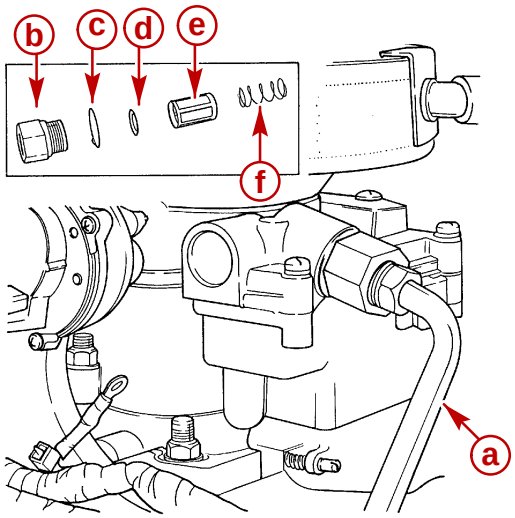
a - Nut
b - Sealing Washer
c - Carburetor
d - Cover (Depending On Model)
e - Crankcase Ventilation Hose
f - Flame Arrestor
g - Positive Crankcase Vent (PCV) Hose (On Carburetor)
h - Positive Crankcase Vent (PCV) Hose

Fuel Inlet Filter

NOTICE
Refer to “Precautions” in this section, BEFORE proceeding.

REMOVAL

1. Remove fuel line from fuel inlet filter nut.
2. Remove fuel inlet filter nut and small gasket.
3. Remove large gasket.
4. Remove filter.
5. Remove spring.
6. Remove small gasket from inside filter nut.



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a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Larger)
d - Gasket (Small)
e - FIlter
f - Spring

CLEANING

1. Clean filter nut and spring in solvent and dry with compressed air.

INSTALLATION

1. Install spring in carburetor body.
2. Install filter, open end to inlet filter nut.
3. Install small gasket inside filter nut.
4. Install large gasket over filter nut threads.
5. Install fuel inlet filter nut. Torque nut to 18 lb-ft (24 Nm).

IMPORTANT: Hold filter nut with wrench while tightening fuel line.

6. Install fuel line. Torque to 18 lb-ft (24 Nm).

Choke Inspection

The choke does not require any periodic maintenance. However, if a choke malfunction is suspected, do the following:

1. With engine turned OFF, remove flame arrestor.
2. Open and close choke several times to check for binding, loose or disconnected linkages or other signs of damage.
3. If choke or linkage binds or sticks, clean with carburetor choke cleaner.

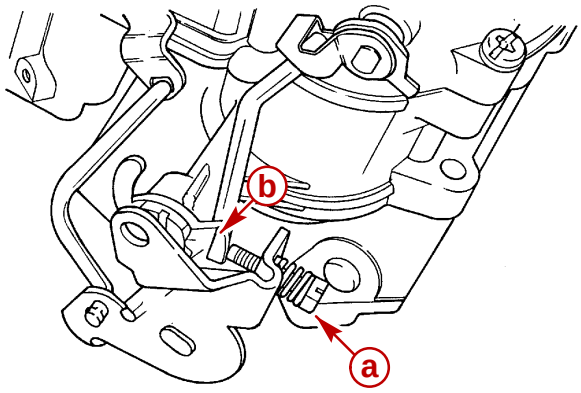
IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

Adjustments

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

Accelerator Rod

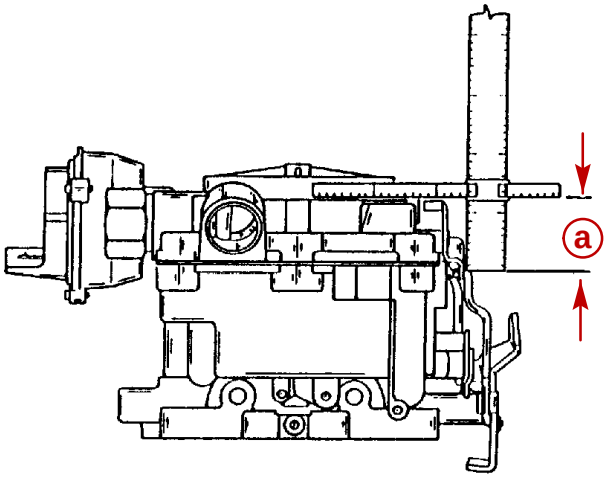
1. Loosen idle speed screw until it no longer contacts idle cam.



72284

a - Idle Speed Screw
b - Idle Cam

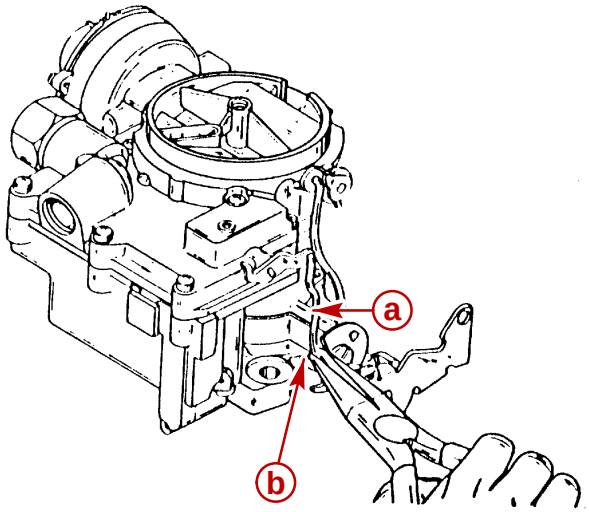
2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod.



72682

a - See Specifications

3. Carefully bend pump rod (where shown) to obtain specified dimension.



72683

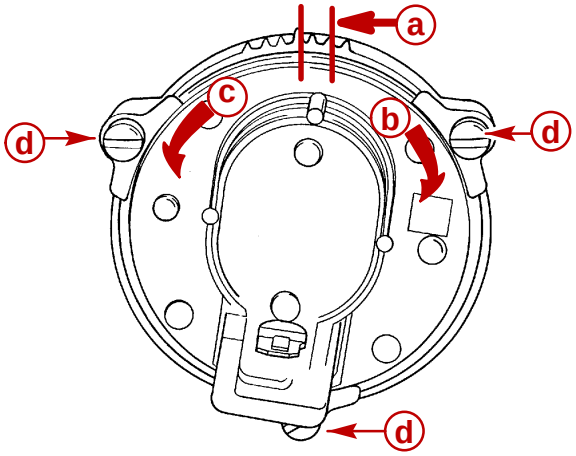
a - Pump Rod
b - Bend Here

Choke Setting

Normal choke setting: mark on cover is set 2 index marks clockwise from larger, center index mark.

If choke adjustment is necessary:

1. Loosen choke cover retaining screws.
2. Adjust as shown.
3. Tighten screws securely.

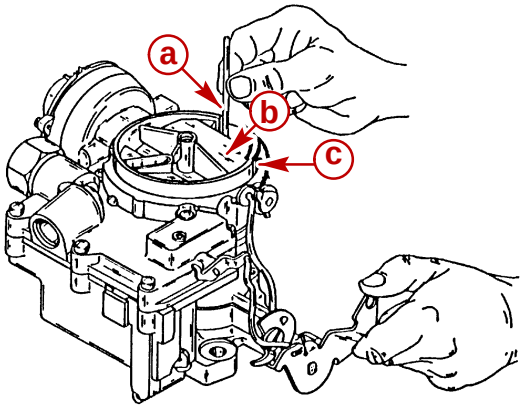


72403

a - Scribed Mark
b - More Choke
c - Less Choke
d - 3 Retaining Screws

Choke Unloader

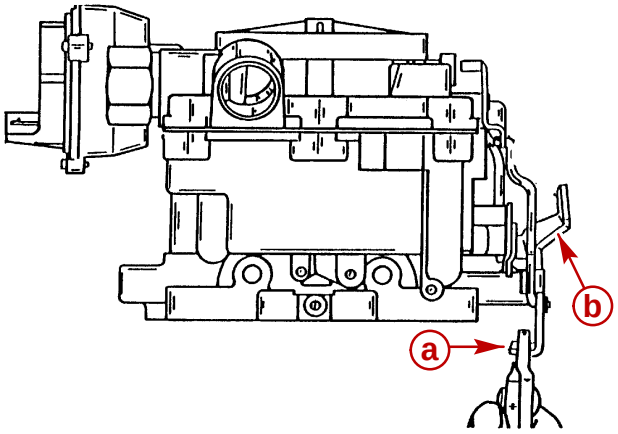
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. [5/64 in.] (0.2 mm) drill rod, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through.



72684

a - .080 in. (0.2mm) Drill Rod
b - Choke Plate
c - Air Horn

4. Bend tang on throttle lever, if necessary, to obtain specified dimension.



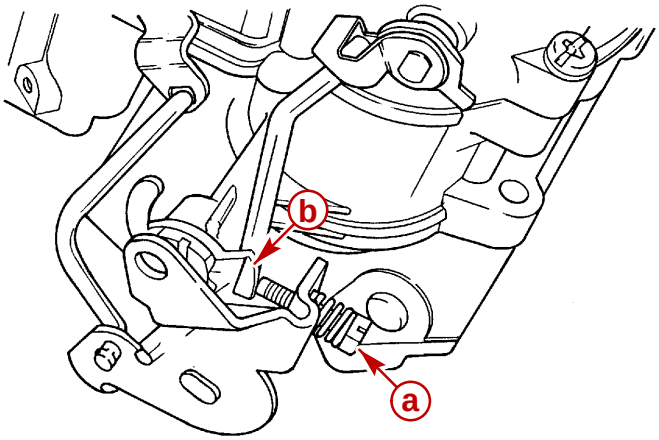
72685

a - Tang
b - Throttle Lever

Initial Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Loosen idle speed screw until it no longer contacts idle cam. Turn idle speed screw in until it just contacts idle cam, then turn screw in an additional two turns.

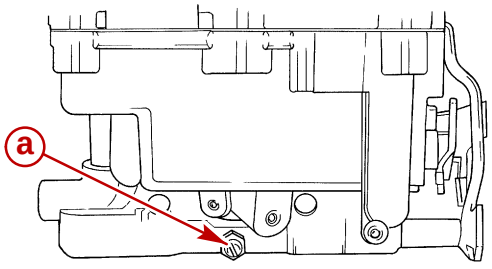


72284

a - Idle Speed Screw
b - Idle Cam

IMPORTANT: DO NOT turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needle in until lightly seated, then loosen needle 1-1/4 turns.



72281

a - Idle Mixture Needle

Final Idle Speed and Mixture

The ignition module must be locked into the timing mode to adjust idle speed and mixture. Refer to SECTION 4B - “Timing - Thunderbolt V Models.”

EMISSIONS CARBURETOR

Sealed Carburetor Mixture Screw

The carburetor on this engine has a seal on the carburetor mixture screw. This seal prevents adjustment of the fuel mixture setting.

⚠ CAUTION
Do not remove mixture screw seal and/or attempt to adjust fuel mixture setting. Tampering with the mixture setting on this engine could affect the exhaust emissions level, thus voiding the emissions certification. This seal should only be removed by an authorized dealer or emissions testing agency.

Replacing Carburetor

NOTICE
Refer to “Precautions” in this section, BEFORE proceeding.

IMPORTANT: First follow the steps in “8 Point Carburetor Check List” to decide if the problem is with the carburetor.

1. Remove the battery cables.
2. Remove the carburetor.
3. Clean gasket surfaces.
4. Use a new gasket and install new carburetor.
5. Hold the carburetor filter nut with a wrench and tighten fuel line fitting securely.
6. Reconnect or install choke wires, vent hoses and flame arrestor.
7. Adjust carburetor and throttle cable.

Repair

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

Removal

IMPORTANT: Carburetor problems are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Remove battery cables.
2. Remove crankcase ventilation and PCV hose from flame arrestor.
3. Remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

4. Turn fuel supply off at fuel tank.
5. Disconnect throttle cable from carburetor.
6. Remove fuel line from fuel inlet nut, using wrench to stabilize fuel inlet nut.
7. Disconnect electric choke.
8. Remove carburetor attaching nuts and washers and remove carburetor.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

9. Remove and discard gaskets.

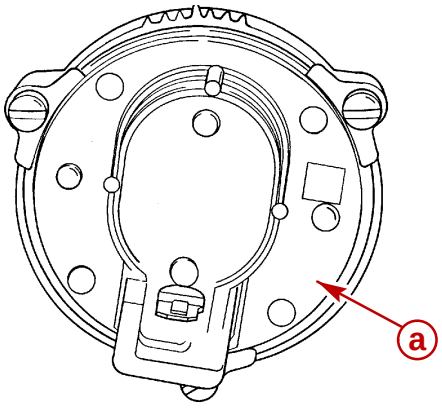
Disassembly

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

The following is a step-by-step procedure for completely overhauling the carburetor removed from engine. Complete overhaul is not always necessary. You should perform only those steps required to repair the carburetor malfunction. Read the instructions carefully to prevent unnecessary steps.

CHOKE HOUSING

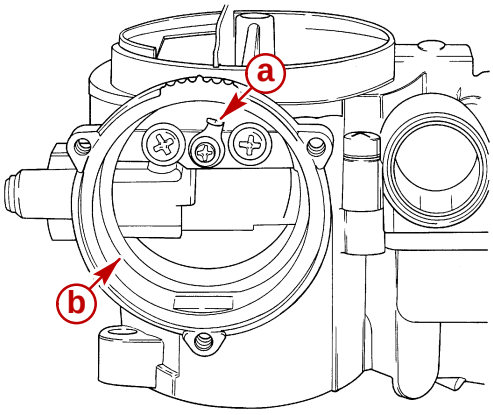
1. Remove choke cover.



72403

a - Choke Cover

2. Remove choke lever. Remove choke housing.



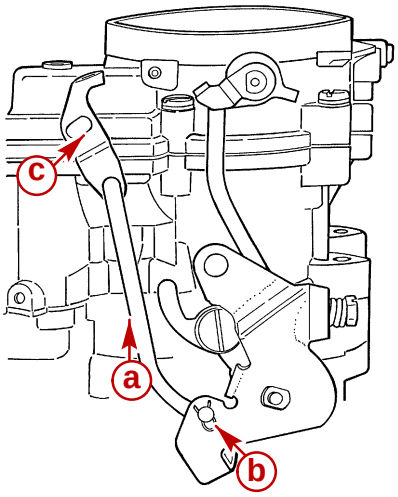
72401

a - Choke Lever
b - Choke Housing

AIR HORN

1. Remove fuel inlet filter nut, washers, spring, and filter.
2. Remove accelerator pump rod retaining clip.

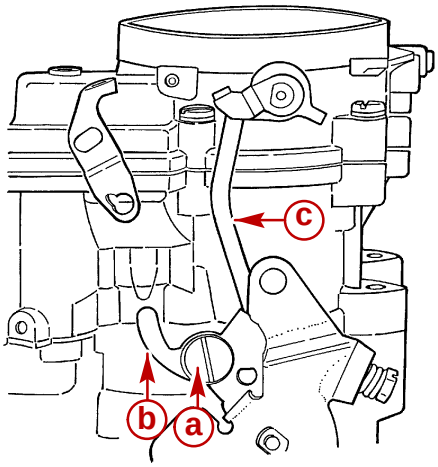
3. Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



72283

a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

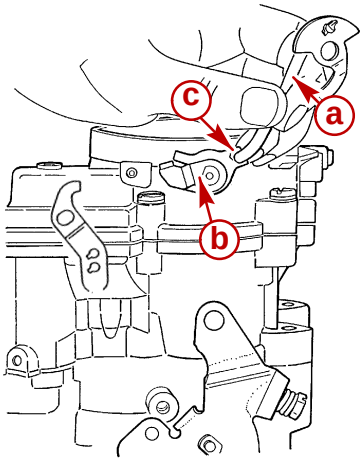
4. Remove idle cam screw.



72282

a - Idle Cam Screw
b - Idle Cam
c - Choke Rod

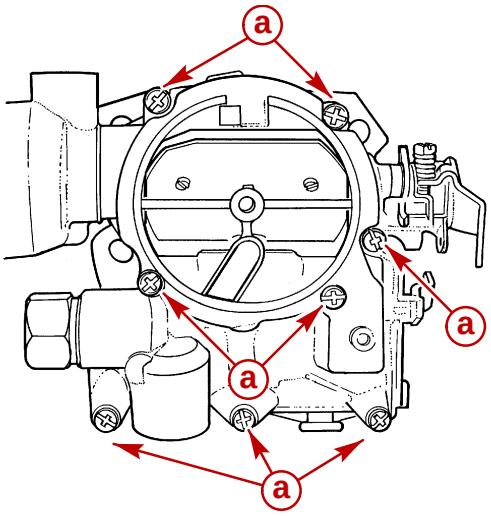
5. Remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out.



72286

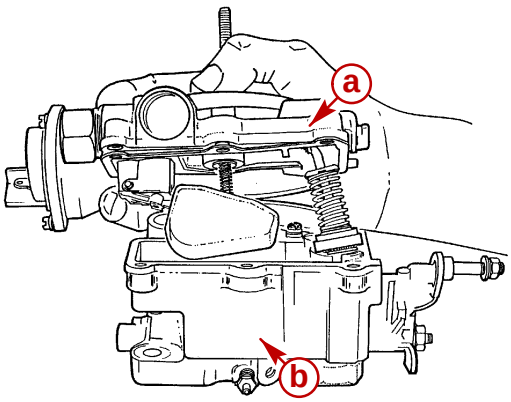
a - Choke Rod
b - Choke Lever
c - Slot

6. Remove air horn attaching screws.
7. Carefully lift air horn from float bowl assembly.



72280

a - Air Horn Attaching Screws

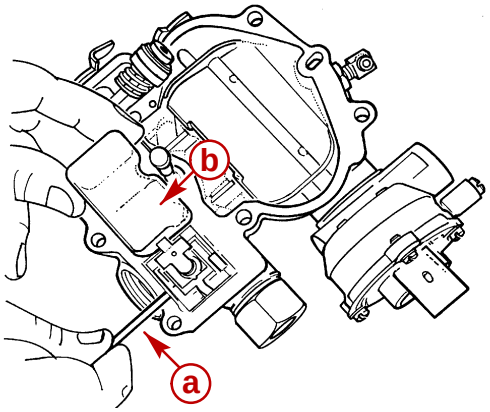


72400

a - Air Horn Assembly
b - Float Bowl Assembly

8. Invert air horn and carefully lay on bench.

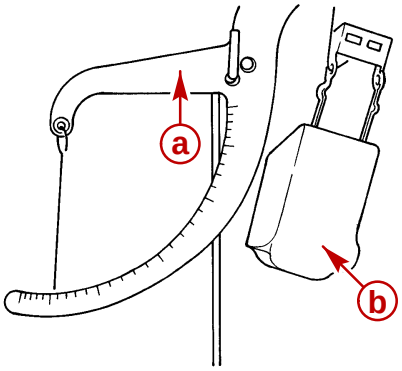
9. Remove float hinge pin and lift float assembly from air horn.



72288

a - Float Hinge Pin
b - Float Assembly

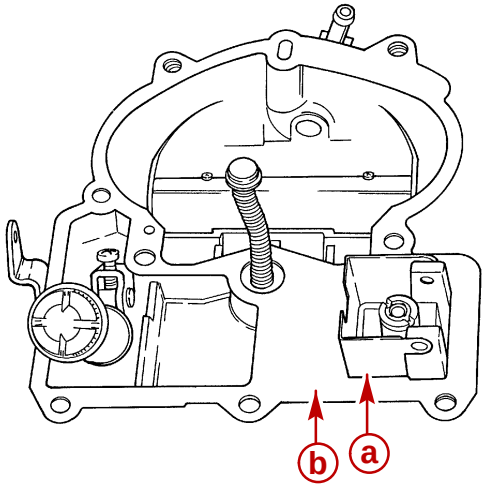
10. Check float weight as shown.



72122

a - Grams Scale
b - Float

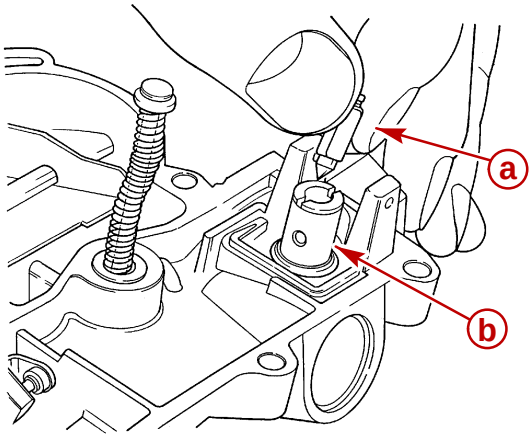
11. Remove air horn gasket and baffle.



72399

a - Baffle
b - Air Horn Gasket

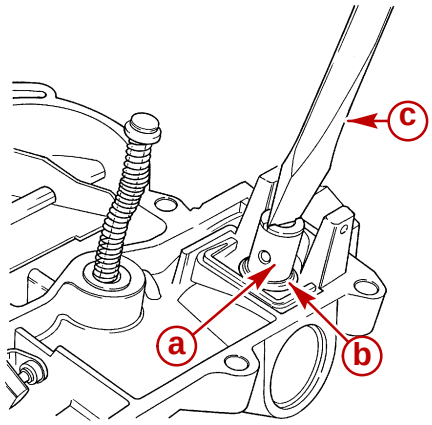
12. Remove needle assembly.



72287

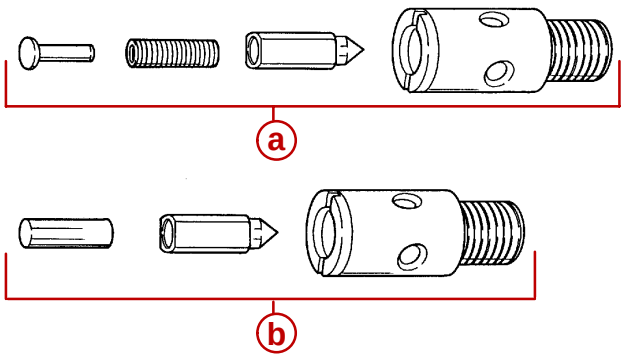
a - Needle Assembly
b - Needle Seat

13. Remove needle seat.



72289

a - Needle Seat
b - Gasket
c - Screwdriver

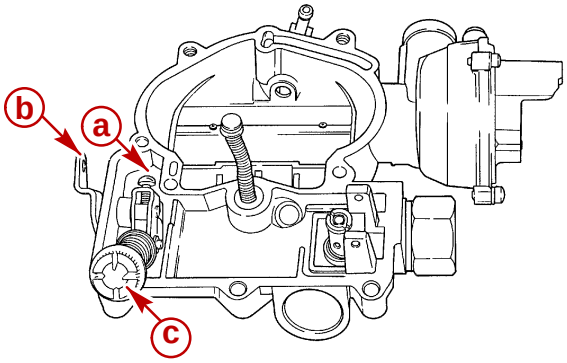


72290

Needle and Seat Assemblies

a - Spring Loaded Type Needle (Kit 3302-9029)
b - Solid Type Needle (Kit 3302-9407)

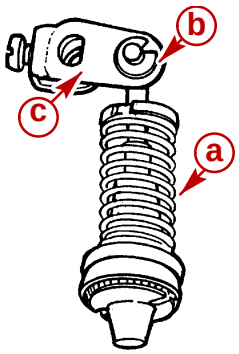
14. Loosen accelerator pump screw.
15. Slide pump shaft and lever assembly (and washer) out of air horn.
16. Remove accelerator pump assembly.



72398

a - Set Screw
b - Lever Assembly
c - Pump Assembly

17. Remove retainer clip and washer from pump shaft and lever assembly, then remove accelerator pump assembly.

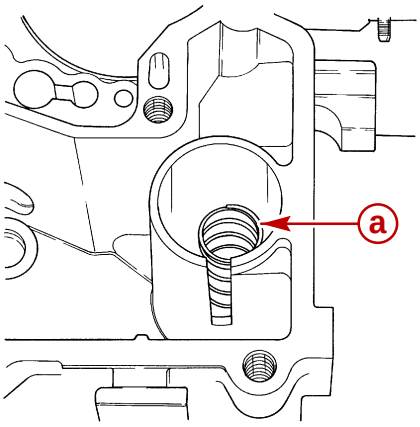


72409

a - Pump Assembly
b - Retainer Clip
c - Lever Assembly

FLOAT BOWL

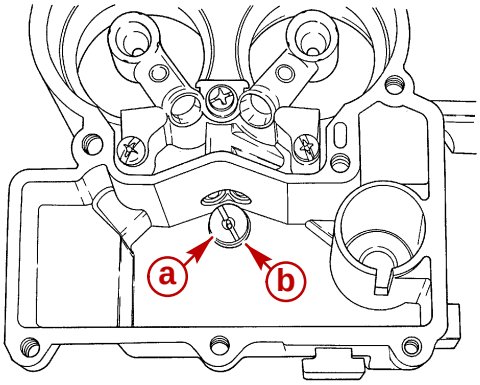
1. Remove accelerator pump return spring from pump well.



72402

a - Accelerator Pump Spring

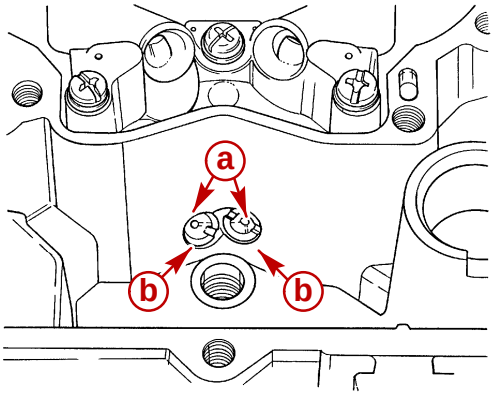
2. Remove power valve assembly and gasket.



72404

a - Power Valve Assembly
b - Gasket (Not Shown)

3. Remove main metering jets.

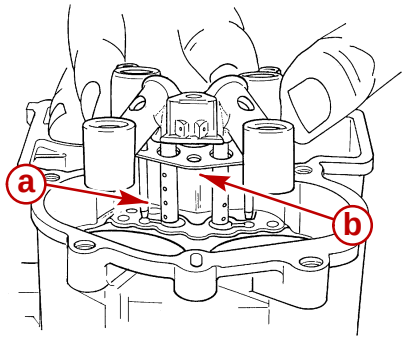


72291

a - Main Metering Jets
b - Gaskets (Not Shown)

IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes which protrude from bottom of cluster. DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable.

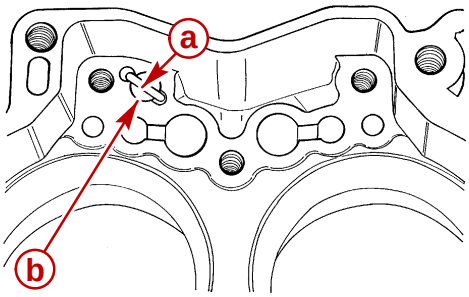
4. Remove venturi cluster screws and carefully lift cluster and venturi gasket straight up.



72397

a - Venturi Cluster Brass Tubes
b - Gasket

5. Using needle-nose pliers, remove accelerator pump check ball spring retainer. Turn float bowl over to remove spring and check ball.

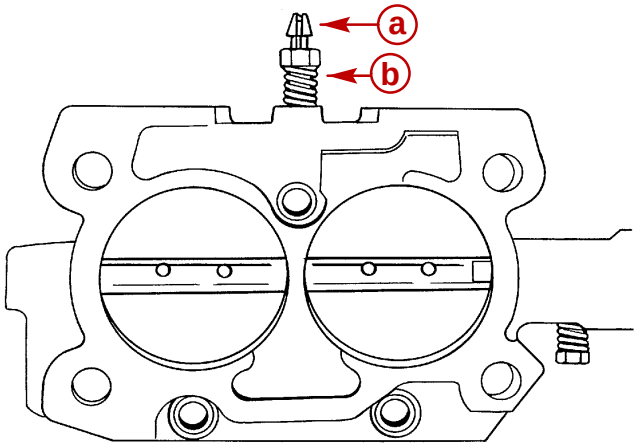


72407

a - Spring Retainer
b - Spring and Check Ball (Not Shown)

IMPORTANT: Use extreme care when handling carburetor body to prevent damaging throttle valves.

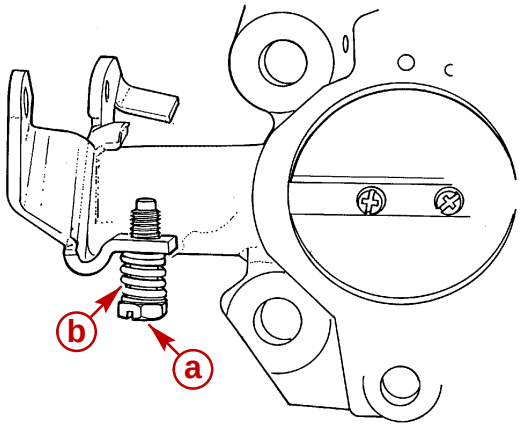
1. Remove idle mixture adjusting needle and spring.



72293

a - Idle Mixture Adjusting Needle
b - Spring

2. Remove idle speed adjustment screw and spring, if replacement is necessary.



72395

a - Idle Speed Screw
b - Spring

IMPORTANT: DO NOT remove throttle valves. If any of the throttle parts are found to be worn or damaged, complete carburetor body assembly MUST BE replaced. Assembly can be cleaned in carburetor cleaner.

Index

Cleaning and Inspection

IMPORTANT: DO NOT use a wire or drill to clean jet passages or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

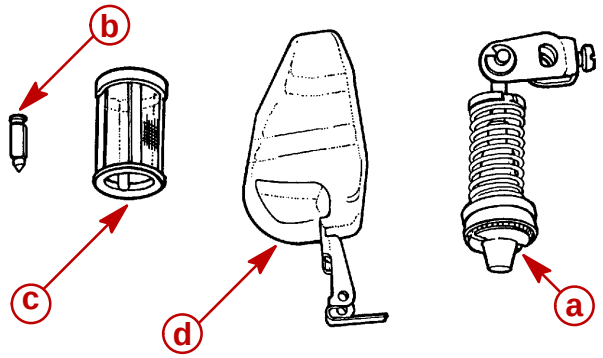
⚠ CAUTION

To avoid damage to carburetor DO NOT leave carburetor in immersion type carburetor cleaner for more than two hours.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠ CAUTION

The float assembly, float needle, accelerator pump plunger and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden and/or distort.



72410

a - Accelerator Pump Plunger
b - Float Needle
c - Fuel Filter
d - Float Assembly

⚠ WARNING

Avoid personal injury by always wearing safety goggles when using compressed air.

1. Clean all metal parts in a commercial carburetor cleaner until all deposits have been removed. Follow cleaner manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage. Pay particular attention to the following:

   a. **Float Needle and Seat**: If float needle or seat is worn or damaged, replace with new needle and seat assembly.

IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Check float density (to see if it is saturated with fuel) by comparing weight of float with specifications. If weight is high, float assembly must be replaced. Check hinge pin and holes for wear.

c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.

d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.

e. **Power Piston Spring:** Check power piston spring for weakness or distortion.

f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.

g. **Levers and Linkages:** Check levers, links and rods for wear.

h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Ensure throttle valve and shaft open and close completely. Throttle body assembly must be replaced if throttle valve and shaft are worn or damaged.

i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding through entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.

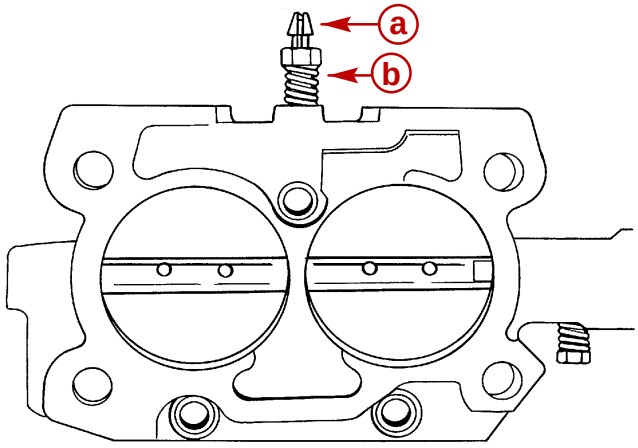
j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

Reassembly

CARBURETOR BODY

IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.

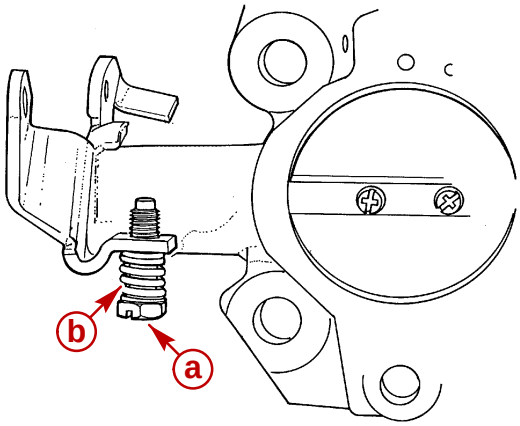
1. Screw idle mixture needle and spring into throttle body until they lightly seat, then back out needle 1-1/2 turns as a preliminary idle mixture setting.



72293

a - Idle Mixing Adjusting Needle
b - Spring

2. Thread idle speed adjustment screw and spring into throttle lever.



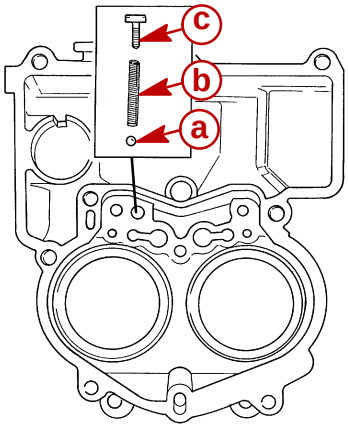
72395

a - Idle Speed Screw
b - Spring

FLOAT BOWL

IMPORTANT: Place float bowl and throttle assemblies in holding fixture to prevent throttle valves from being damaged.

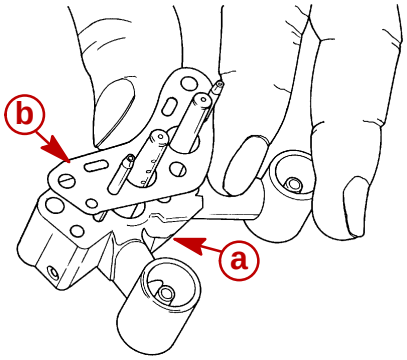
1. Install check ball, spring, and retainer in passage. Push retainer firmly into slots.



72408

a - Check Ball
b - Spring
c - Retainer

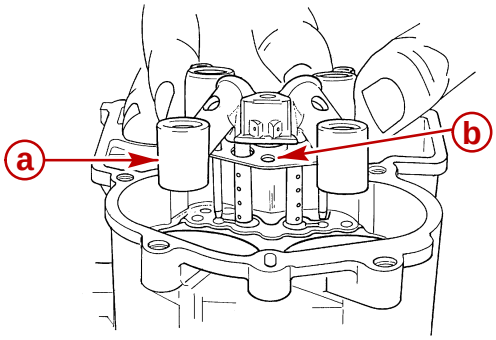
2. Install new gasket on venturi cluster.



72296

a - Venturi Cluster
b - Gasket

3. Install venturi cluster in carburetor.

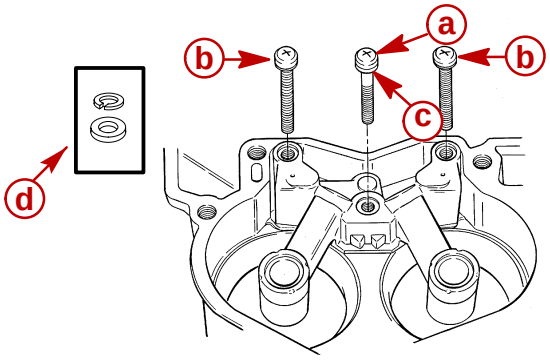


72397

a - Venturi Cluster
b - Gasket

4. Install flat washer and new fiber washer on center screw. Lockwashers and flat washers are used on outer screws. Tighten screws evenly and securely.

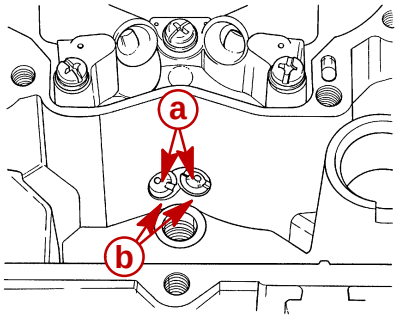
IMPORTANT: Do not damage the fiber washer. A damaged washer will cause improper fueling.



72405

a - Center Screw
b - Outer Screws
c - Fiber Washer
d - Lock Washer and Flat Washer

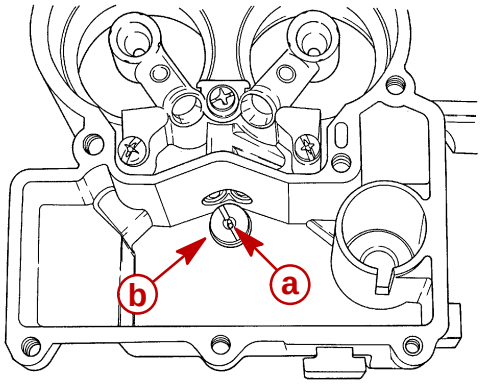
5. Install main metering jets with gaskets. Tighten securely.



72291

a - Main Metering Jets
b - Gaskets (Not Shown)

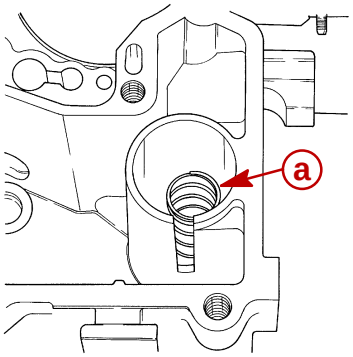
6. Install power valve with new gasket. Tighten securely.



72404

a - Power Valve
b - Gaskets (Not Shown)

7. Place accelerator pump spring in pump well.



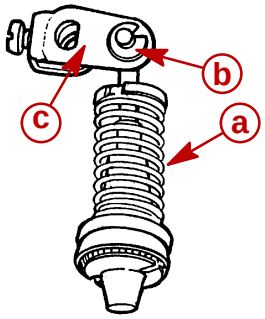
72402

a - Accelerator Pump Spring

AIR HORN

IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

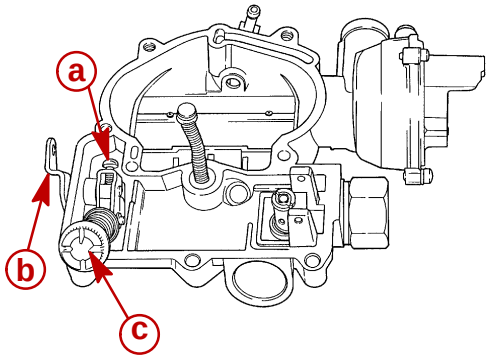
1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip.



72409

a - Pump Assembly
b - Retainer Clip
c - Pump Lever

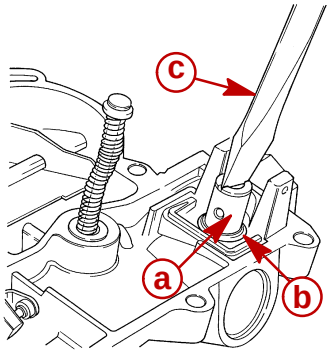
2. Insert pump shaft and lever assembly (and washer) into air horn.
3. Align indexed hole in pump lever with shaft and lever assembly and slide shaft all the way into lever so that shoulder on shaft is hitting lever.
4. Tighten set screw securely.



72398

a - Set Screw
b - Lever Assembly
c - Pump Assembly

5. Install needle seat and gasket. Tighten securely.

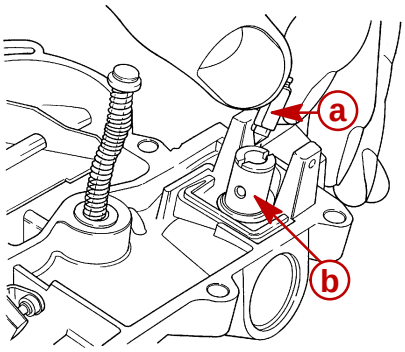


72289

a - Needle Seat
b - Gasket
c - Screwdriver

IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

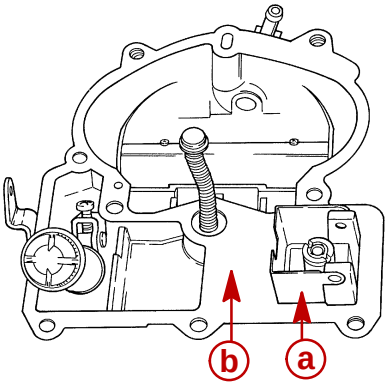
6. Place needle assembly in needle seat.



72287

a - Needle Assembly
b - Needle Seat

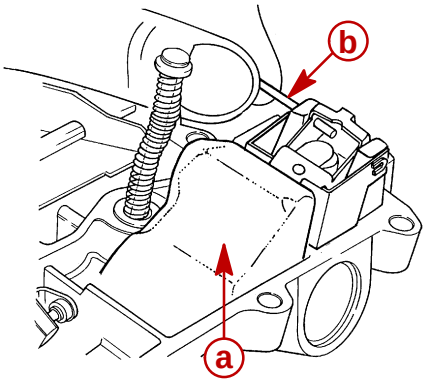
7. Install baffle and gasket.



72399

a - Baffle
b - Gasket

8. Install float assembly and hinge pin. Pivot float assembly up and down on hinge pin to ensure it moves freely.



72297

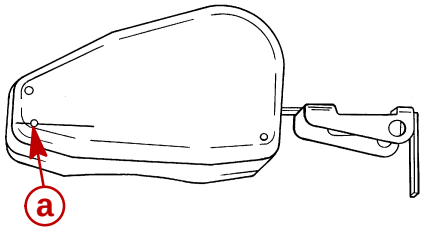
a - Float Assembly
b - Float Hinge Pin

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly up and down on hinge pin to ensure it moves freely.

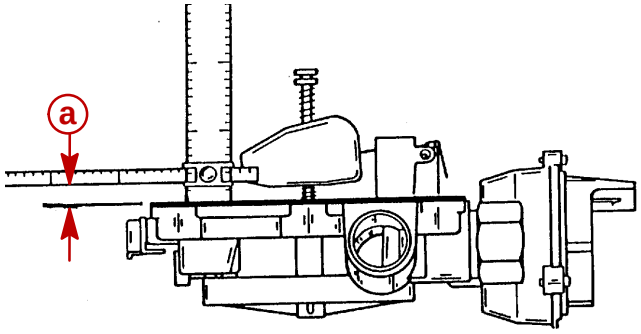
IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT force downward by hand.

2. Measure float level using Universal Carburetor Gauge (91-36392). Measure from gasket to toe of float.



72298

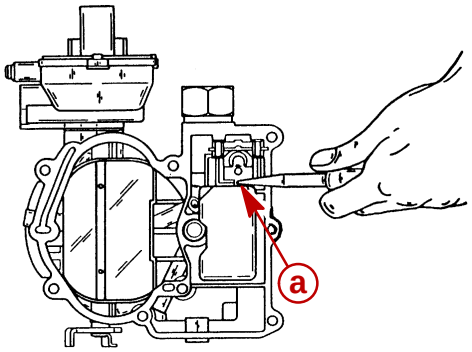
a - Measure From This Point (Dot) To Gasket



72687

a - Measurement With 2 Piece Solid Inlet Needle - 3/8 in. (10 mm)
b - Measurement with Spring Loaded Inlet Needle - 11/32 in. (9 mm)

3. Bend float arm up or down at point shown to obtain specified dimension.



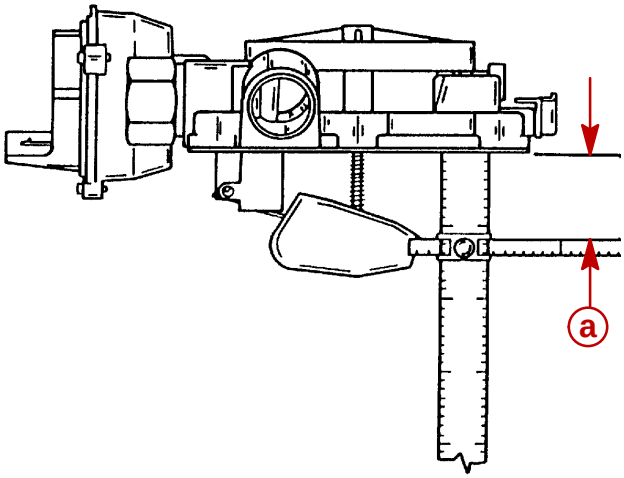
72688

a - Bend Float Arm at This Point

4. Visually check float alignment after adjustment.

FLOAT DROP

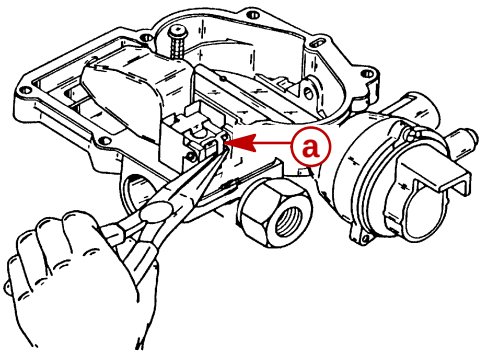
1. Hold air horn right side up to allow float to hang free.
2. Measure float drop using Universal Carburetor Gauge (91-36392). Measure from gasket (air horn) to “dot” on float.



72689

a - Measurement - 15/16 in. (24 mm)

3. Bend float assembly tang, as shown, to obtain specified dimension.



72690

a - Float Assembly Tang

4. Recheck BOTH float level and float drop.

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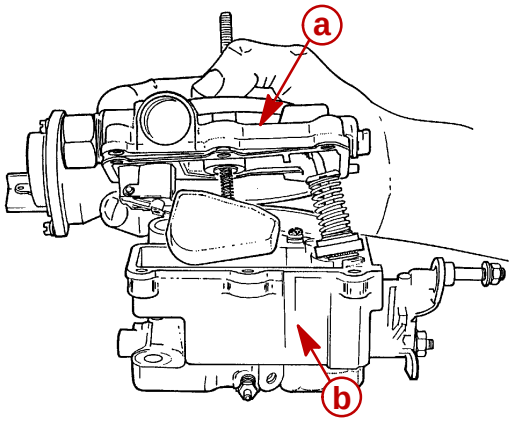
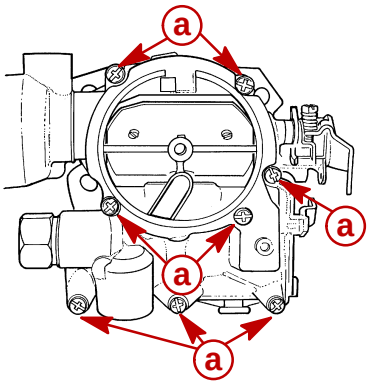
5. Place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install.



72400

a - Air Horn Assembly
b - Float Bowl Assembly

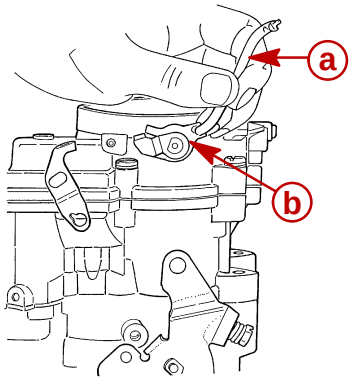
6. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely.



72280

a - Air Horn Attaching Screws

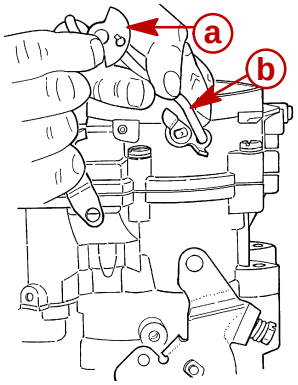
7. Place end of choke rod in choke lever and collar assembly.



72299

a - Choke Rod
b - Choke Lever and Collar Assembly

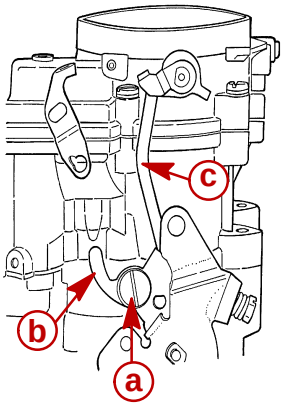
8. Place idle cam on choke rod.



72392

a - Idle Cam
b - Choke Rod

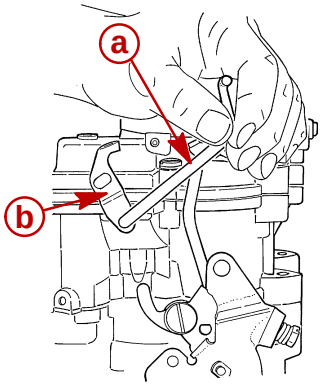
9. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. Ensure that cam is free to move without binding.



72282

a - Screw
b - Idle Cam
c - Choke Rod

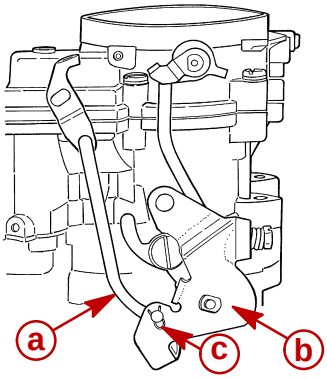
10. Place accelerator pump rod in hole in pump shaft and lever assembly.



72393

a - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

11. Insert other end of accelerator pump rod into hole in throttle lever and secure with retainer clip.

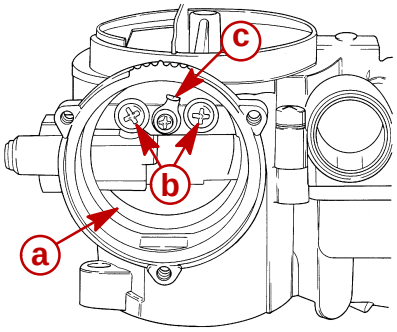


72283

a - Accelerator Pump Rod
b - Throttle Lever
c - Retainer Clip

CHOKE HOUSING

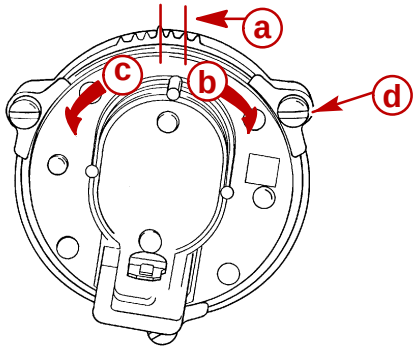
1. Install choke housing on air horn. Tighten screws securely.
2. Install choke lever. Tighten screw securely.



72401

a - Choke Housing
b - Choke Housing Attaching Screws
c - Choke Lever

3. Install choke cover. Make sure hook on end of choke coil engages with choke lever.
4. Adjust choke cover until index marks align as shown. Tighten screws securely.



72403

a - Scribed Mark
b - More Choke (Richer)
c - Less Choke (Leaner)
d - Cover Screws

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Installation

1. Thoroughly clean gasket surfaces and install new gaskets.
2. Place new carburetor base gasket on intake manifold.
3. Install carburetor and secure with nuts and washers. Torque to 132 lb-in. (15 Nm).
4. If fuel inlet filter nut was disturbed, remove, clean all threads with brush and carburetor cleaner or Quicksilver Leveler, and replace.
5. Connect fuel line to fuel inlet filter nut. Hold filter nut with wrench, tighten fuel line fitting securely.
6. Connect electric choke wires to choke cover.
7. Install throttle cable. Refer to SECTION 2.
8. Install flame arrestor, crankcase ventilation and PCV hose.
9. Reconnect battery cables to battery.
10. Ensure that water is supplied to cooling system.
11. Start engine.
12. Check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
13. Adjust idle speed and idle mixture.

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FUEL SYSTEMS

Section 5C - Weber 4 Barrel Carburetor

5 C

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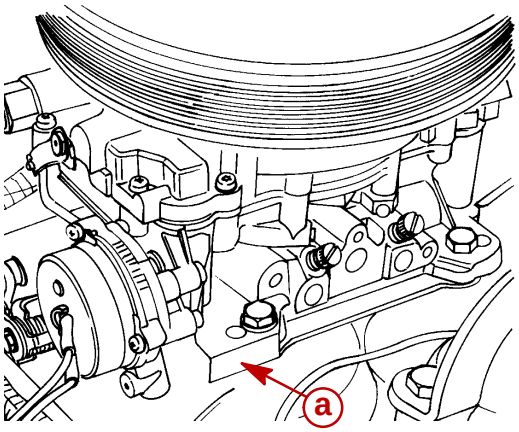
Identification



75682

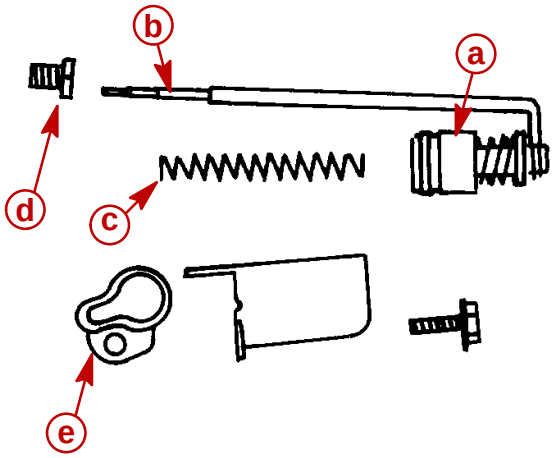
a - Weber Identification Number Location

NOTICE
For information and procedures on troubleshooting, refer to SECTION 1C.

Carburetor Metering Rod And Jet Identification

METERING ASSEMBLY

The metering rod assemblies are shown in the following:



73732

Three Step Metering Rod

a - Piston
b - Metering Rod
c - Spring
d - Jet
e - Piston Cover

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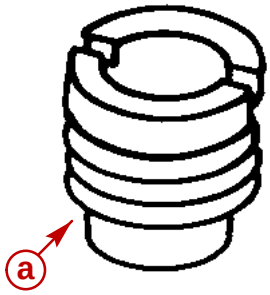
METERING JETS

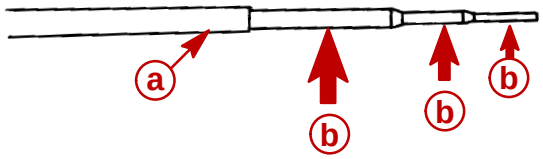
The metering jets in this carburetor are as shown.



73728

a - Three Step Metering Rod Jet

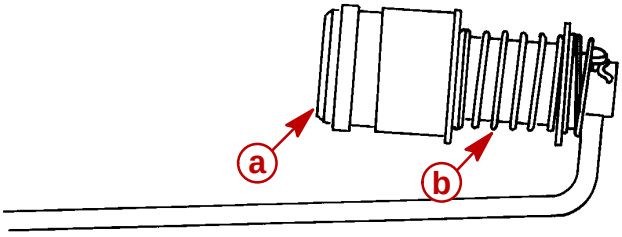
METERING ROD HAS THREE STEPS



73726

a - Metering Rod
b - Steps (3)

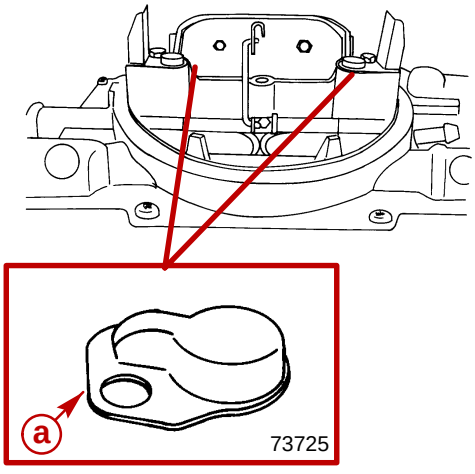
PISTON SHAPE WITH SECOND SPRING



73730

a - Piston
b - Second Spring

THREE STEP PISTON ASSEMBLY COVER



73735

a - Cover

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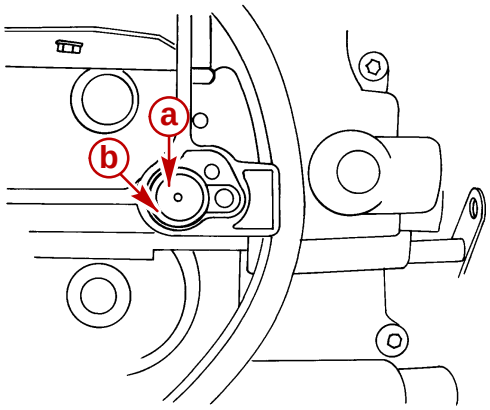
PISTON BORE STEP



73737

a - Piston Bore
b - Step

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Carburetor To Manifold	132		15
Fuel Line To Carburetor		18	24
Fuel Inlet Filter Nut		18	24

Specifications

Engine Model	4.3LH Alpha and Bravo	
Carburetor Type	WFB	
Mercury Number (Manufacturer Number)	3310-807826 (9666S)	
Primary Jet Size	.092 in.	
Secondary Jet Size	.089 in.	
Metering Rod Number	16-686457	
Metering Rod Spring Color	Green	
Float Level	1-9/32 in. (33 mm)	
Float Drop	2 in. (51 mm)	
Pump Rod Hole Location	Third Hole From End	
Accelerator Pump	7/16 in. (11 mm) [1]	
Choke Pull Off	1.28 (32.5)	
Electric Choke Setting	Lean - Counter-clockwise	Rich - Clock-wise
Idle Mixture Screw Setting	1-1/4 Turns	

[1] Measurement taken from top of carburetor to bottom of S-link

NOTE: *All measurements are +/– 1/64 in. (0.4 mm)*

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Tools

Description	Part Number
Universal Carburetor Gauge	91-36392
Tachometer	91-59339
Universal Carburetor Stand	Obtain Locally
Torx® Screwdriver (15, 20, 25)[1]	

1 : Weber carburetors will have a “star” shaped socket in the head of some screws. A TORX® screwdriver must be used on this type of screw. The sizes used are numbers 15, 20 and 25.

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your Mercury MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing or water pickup inlet, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Fuel Delivery System

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVERTIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

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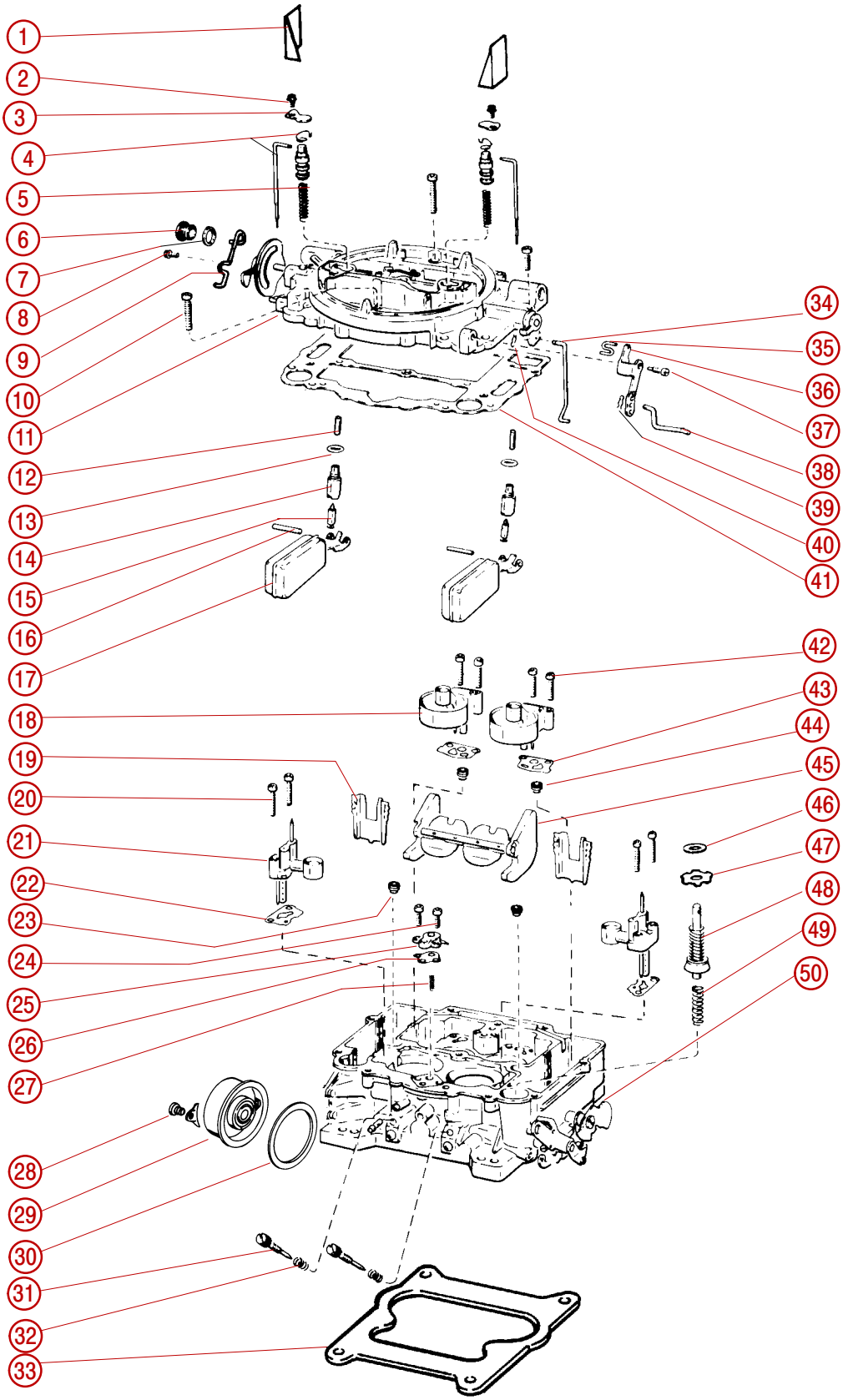
8 Point Carburetor Check List

To ensure that the carburetor is the cause of the engine s problem, make the following checks BEFORE ordering and installing a new carburetor. If questions 1, 2, 3, 5, 6 and 7 are YES and 8 is NO, the carburetor may not be the problem.

1. Does the choke close completely (before starting)? Y N
2. Does the choke open completely (during engine warm up)? Y N
3. Are idle mixture screws set correctly? Y N
   (Engines with Thunderbolt V ignition must have module locked in base timing mode).
4. What is the idle mixture screw setting? Choke side: _____ Turn.
   Cable side: _____ Turn.
5. Is the engine idle speed (rpm) correct? Y N
6. Is primary venturi cluster discharging fuel (by 2000 rpm)? Y N
7. Is a good stream of fuel being discharged by both pump injector nozzles? (When throttle lever is pumped with engine off). Y N
8. Does the engine flood at idle? Y N

Exploded View



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1-Air Deflector (2)
2-Screw (2)
3-Cover, Metering Rod (2)
4-Metering Rod Assembly (2)
5-Spring, Metering Rod (2)
6-Fuel Inlet Fitting
7-Sealing Washer
8-Screw
9-Linkage Rod, Choke Pull-Off
10-Screw
11-Air Horn (Carburetor Top)
12-Filter, Fuel Inlet (2)
13-Gasket (2)
14-Seat, Fuel Inlet (2)
15-Needle Valve, Fuel Inlet (2)
16-Pin (2)
17-Float (2)
18-Secondary Venturi Cluster (2)
19-Baffle Plate, Float Bowl (2)
20-Screw (4)
21-Primary Venturi Cluster (2)
22-Gasket (2)
23-Jet, Primary Fuel (2)
24-Screw (2)
25-Fuel Pump Injector Housing
26-Gasket
27-Check-Spring
28-Screw and Clip
29-Electric Choke Assembly
30-Retainer, Choke
31-Idle Mixture Screw (2)
32-Spring, Idle Mixture Screw (2)
33-Gasket, Carburetor Base
34-Linkage Rod, Choke Plate
35-S-Link
36-Accelerator Pump Lever
37-Screw
38-Linkage Rod, Accelerator Pump
39-Wire Clip
40-Wire Clip
41-Gasket
42-Screw (4)
43-Gasket (2)
44-Jet, Secondary Fuel (2)
45-Secondary Air Valve and Weight Assembly
46-Plunger Washer
47-Plunger Guide
48-Accelerator Pump
49-Spring, Accelerator Pump
50-Float Bowl/Body (Carburetor Bottom)

Description

Weber WFB carburetor is unique in design, as the main body and flange are cast as a one piece unit. This, along with the bowl cover, make up the two piece construction that is made of light, durable aluminum to dissipate heat.

There are two separate float circuits. Each float circuit supplies fuel to a primary low speed circuit and a primary and secondary high speed circuit. The bowls are vented to the inside of the air horn. A connecting vent passage affects the balance of the air pressure between the two bowls.

The float needle valves are installed at an angle to provide the best possible seating action on the needles. This also provides better needle response to float movement.

The high speed circuits use staged step-up rods in the main metering jets to control the amount of fuel admitted to the nozzles. The position of the step-up rod is controlled by manifold vacuum applied to the vacuum piston.

A primary air bleed located in the venturi cluster prevents a rich condition or bog as the high speed circuit is reactivated after deceleration.

Small “L” shaped metal tabs, called “distribution tab(s),” are attached to some venturi clusters and protrude into the air stream at the proper location to aid distribution of fuel on selected applications.

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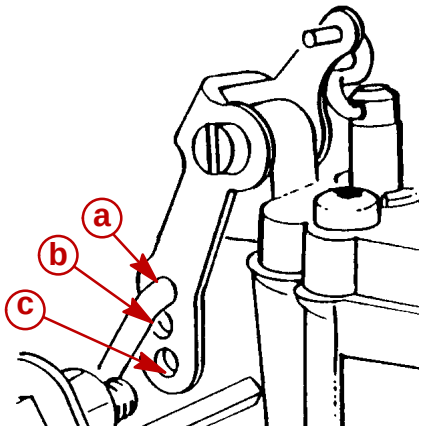
Important Service Information

Adjustable Accelerator Pump Lever

The accelerator pump lever on Weber Carburetors has three holes in it. The closest hole to the lever's pivot point is the richest, the second hole is leaner and the hole furthest away is the leanest. All production carbs have the pump rod installed in the closest (richest) hole. If you are having a "rich" bog on acceleration, move the rod to the second or third hole. Weber put the three holes in the lever so the amount of fuel delivered by the accelerator pump could be changed.



70472

a - Rich
b - Lean
c - Leaner

Hard Starting

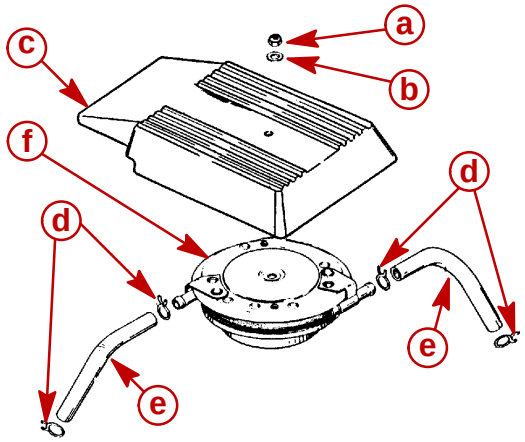
If a hard starting condition exists, after engine has not been operated for a period of time, proceed with the following:

1. Before starting engine, remove flame arrestor then operate throttle to see if choke closes.
2. If choke is stuck open, check choke and choke linkage on both sides of carburetor for cause of sticking. Possible paint or interference to rod or linkage.
3. Check for any paint or binding on choke rod linkages.
4. Make sure choke is getting 12 volts.
5. Make sure choke opens all the way after 3 minute running.

Maintenance

Flame Arrestor

NOTICE
Refer to “Precautions,” in this section, BEFORE proceeding.



71372

Flame Arrestor with Carburetor Cover (Typical)

- **a** - Nut
- **b** - Sealing Washer
- **c** - Cover
- **d** - Clamps
- **e** - Crankcase Ventilation Hose
- **f** - Flame Arrestor

REMOVAL

1. Remove nut.
2. Remove sealing washer.
3. Remove carburetor cover.
4. Remove crankcase ventilation hoses from flame arrestor and rocker arm covers.
5. Remove flame arrestor.

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent and blow dry with compressed air.
2. Clean crankcase ventilation hoses.
3. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

INSTALLATION

1. Install flame arrestor.
2. Install crankcase ventilation hoses to flame arrestor and rocker arm covers.
3. Install carburetor cover.
4. Install sealing washer.
5. Install nut. Tighten securely.

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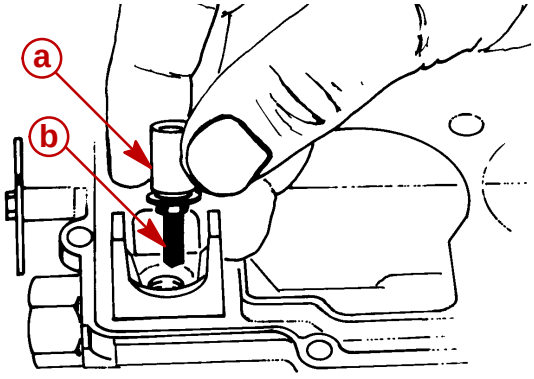
Fuel Inlet Filter

NOTICE
Refer to “Precautions,” in this section, BEFORE proceeding.

Carburetor inlet fuel filter is installed in bottom side of fuel inlet seat (in the carburetor top). Refer to “Disassembly” and “Reassembly” to service.



70447

a - Fuel Inlet Seat (with Gasket)
b - Fuel Inlet Filter

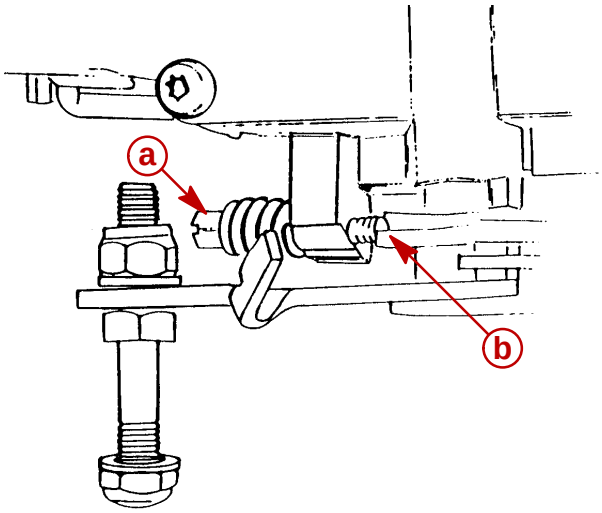
Adjustments

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

Accelerator Pump

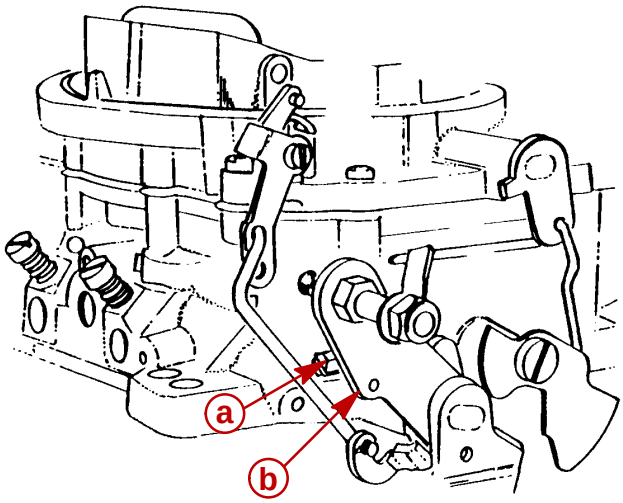
IMPORTANT: Refer to “Important Service Information” in this section, regarding the three accelerator pump linkage holes and placement of linkage rod.

1. Loosen idle speed screw until it no longer contacts throttle lever.



70474

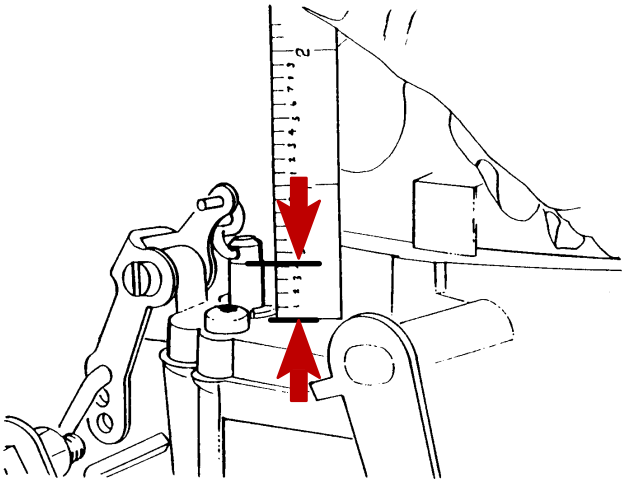
a - Idle Speed Screw
b - Throttle Lever Contact Point



70473

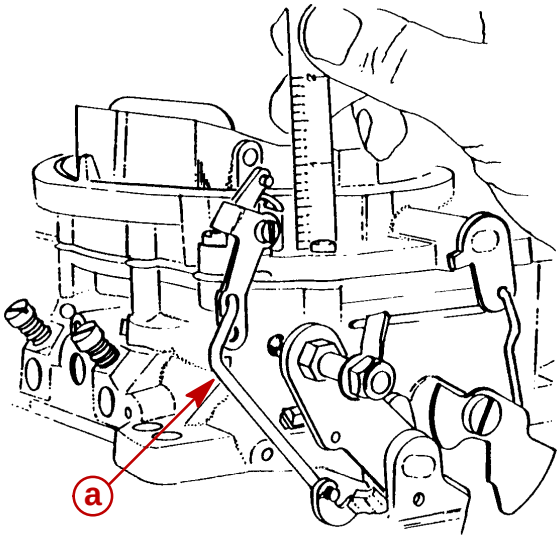
a - Idle Speed Screw
b - Throttle Lever

2. Accelerator pump is set at 7/16 in. (11 mm), which is measured from the carburetor top to the bottom of the S-link as shown.



70472

3. Adjustment of accelerator pump is done by bending the linkage as necessary to achieve the proper dimension as stated above.

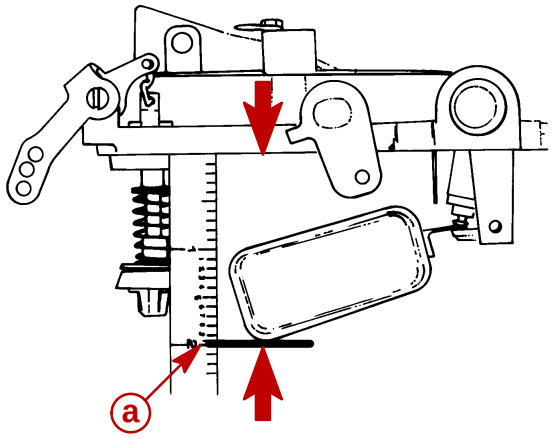


70473

a - Bend Here

Float Drop

1. Measure float drop from bottom side of carburetor top to toe of float (lowest part). It must be set at 2 in. (51 mm).

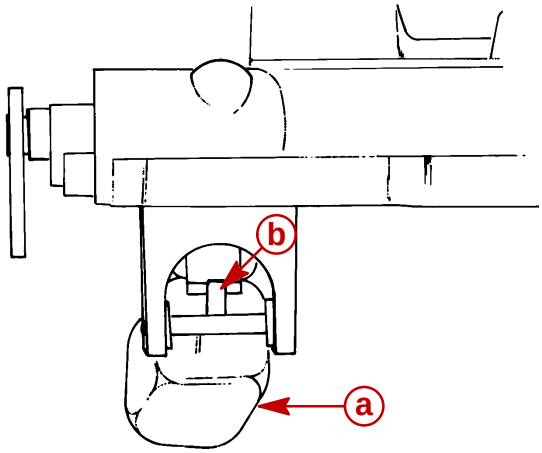


70469

a - Drop Measurement

2. If float drop is not correct, hold hinge pin firmly and bend tab, as needed.

IMPORTANT: Do not put pressure on fuel needle valve and seat while bending tab or damage may result.



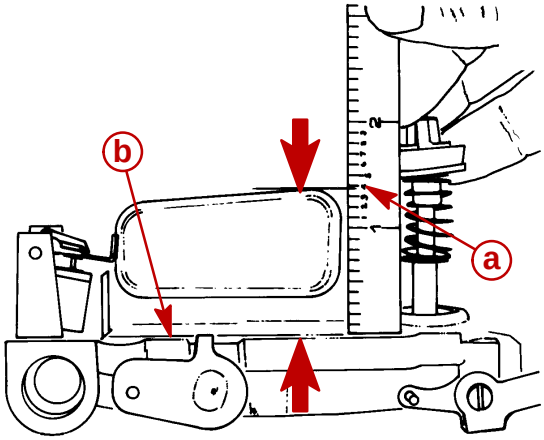
70470

a - Float
b - Tab (Bend)

Index

Float Level

1. Measure float level from bottom side of carburetor top (with gasket in place) to toe of float as shown. It must be set at 1-9/32 in. (33 mm).

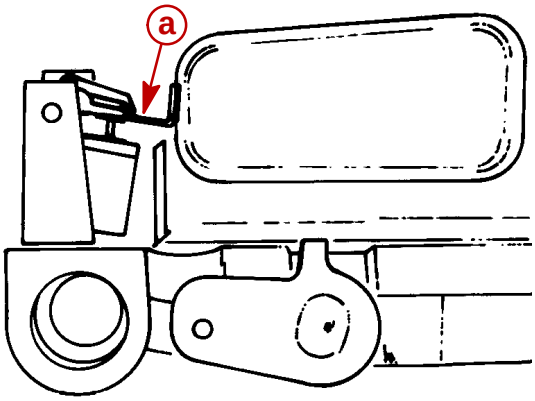


70468

a - Float Level Measurement
b - Gasket

2. If float level requires adjustment, hold hinge pin firmly and bend float arm shown, as needed.

IMPORTANT: Do not put pressure on fuel needle valve and seat while bending tab, or damage may result.

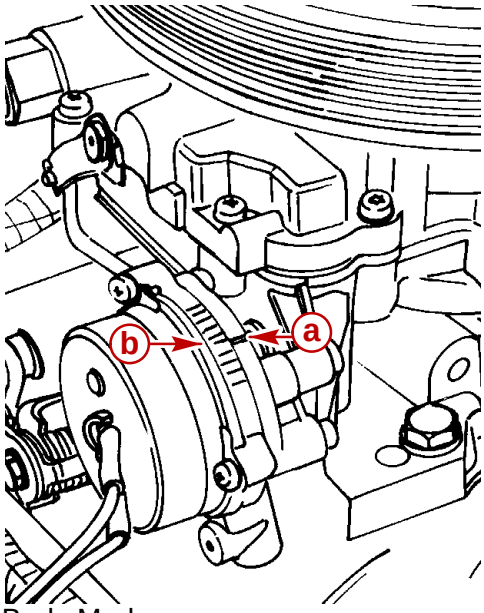


70468

a - Float Level Tab (Bend)

Electric Choke

The electric choke should be set with marks aligned.



75862

a - Carburetor Body Mark
b - Choke Marks

1. Loosen choke housing screws
2. Adjust choke by turning.

Idle Speed and Mixture

IMPORTANT: In order to properly set idle mixture, the ignition module MUST BE locked in the Base Timing Mode. This is necessary because of the Idle Speed Control feature that exists in the ignition module. See information on the previous pages about this feature.

1. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the Base Timing Mode.
2. Disconnect throttle cable.
3. Set idle speed (rpm) screw so engine idles at 550-600 rpm in neutral.
4. Adjust idle mixture screws.
5. Reset the idle speed screw so engine idles at its recommended rpm.
6. Adjust and connect throttle cable.
7. Remove the jumper wire from the timing terminal.

ENGINE IDLE SPEED

This procedure should be done with boat in the water, drive unit in neutral and engine at normal operating temperature. Refer to the Operation and Maintenance Manual for the correct idle speed.

1. Disconnect the throttle cable from carburetor.

IMPORTANT: In order to properly set idle speed, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module.

2. Connect a shop tachometer to engine.

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3. Using a jumper wire, connect the ignition system timing lead 13 (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the Base Timing Mode.
4. Start engine and allow it to reach normal operating temperature. Place the remote control lever in forward gear, idle position.
5. Adjust idle speed to recommended rpm.
6. Stop engine. Readjust cable barrel and reinstall the throttle.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the Base Timing Mode. This means that the additional timing advance features would not be functioning.

7. Remove the jumper wire from the timing terminal.

Replacing Carburetor

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

IMPORTANT: First follow the steps in “8 Point Carburetor Check List” to decide if the problem is with the carburetor.

1. Remove the battery cables.
2. Remove the carburetor.
3. Clean gasket surfaces.
4. Use a new gasket and install new carburetor.
5. Hold the carburetor filter nut with a wrench and tighten fuel line fitting securely.
6. Reconnect or install choke wires, vent hoses and flame arrestor.
7. Adjust carburetor and throttle cable.

Repair

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

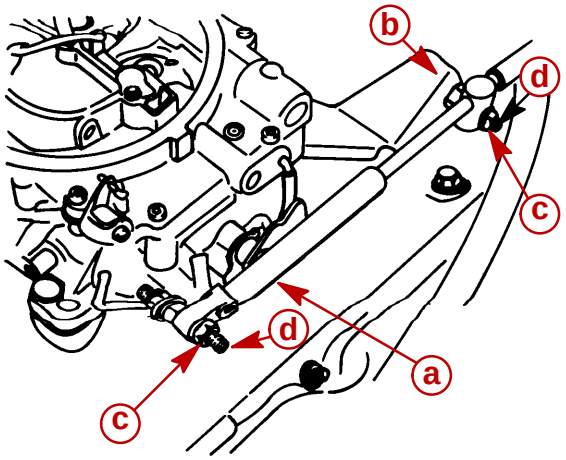
Removal

IMPORTANT: Carburetor malfunctions are often caused by the presence of dirt, water or other foreign matter. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Turn off fuel supply at fuel tank.
2. Remove carburetor cover. Remove crankcase ventilation hoses from flame arrestor, then remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

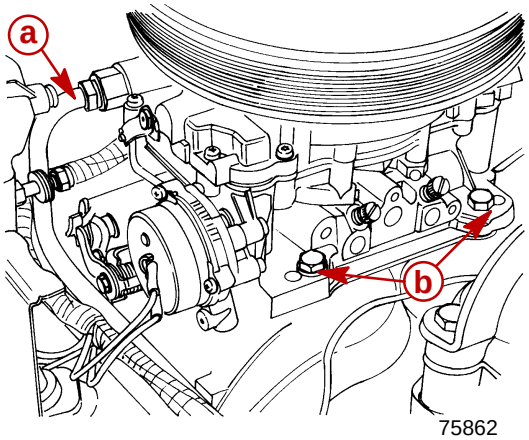
3. Disconnect throttle cable attaching hardware from throttle bracket and throttle lever anchor studs. Remove throttle cable.



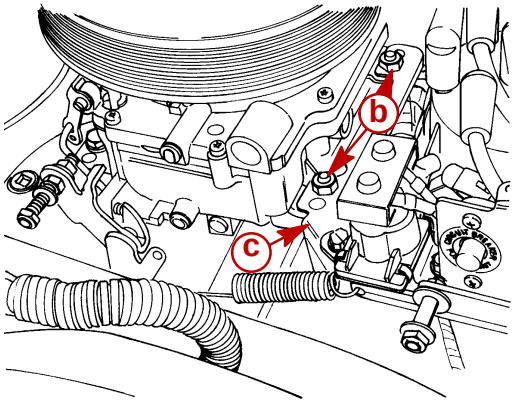
71097

a - Throttle Cable
b - Bracket
c - Attaching Hardware
d - Anchor Studs

4. Remove fuel line and carburetor attaching hardware. Remove carburetor and throttle bracket. Discard gasket.



75862



75863

a - Fuel Line
b - Attaching Hardware
c - Throttle Bracket

IMPORTANT: Cover intake manifold to prevent entry of dirt or foreign material through openings.

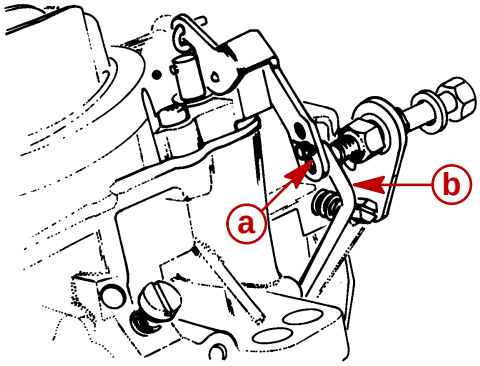
5. Place a clean cloth over intake manifold openings.

Disassembly

The following is a step-by-step procedure for completely overhauling carburetor after removal from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

1. Remove wire clip to disconnect accelerator pump linkage.



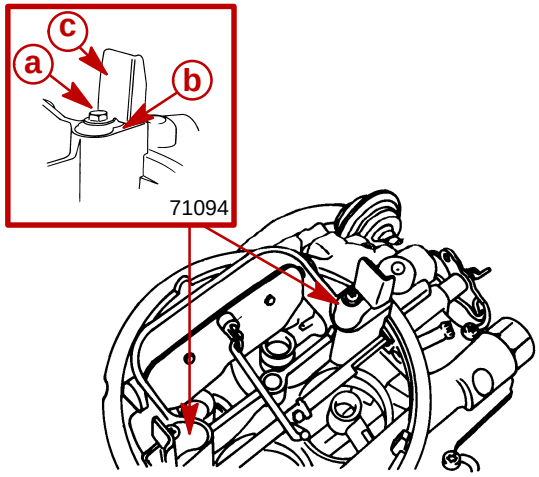
70390

a - Wire Clip
b - Accelerator Pump Linkage Rod

2. Remove wire clip and disconnect electric choke link rod from choke plate lever.

IMPORTANT: Metering rods should always be removed before separating top and bottom halves of carburetor.

3. Loosen (not necessary to remove, depending on amount of service required) metering rod cover screws. Turn or remove cover to expose metering rod.

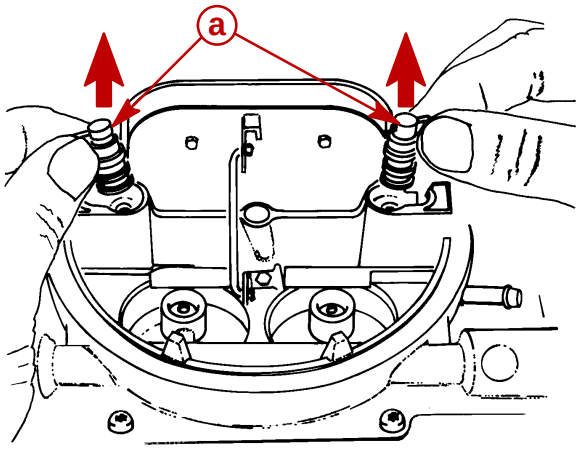


71095

a - Screws
b - Metering Rod Cover(s)
c - Air Deflectors If Equipped)

IMPORTANT: Be careful not to mix metering rods when removing them.

4. Carefully lift metering rod assemblies straight out.

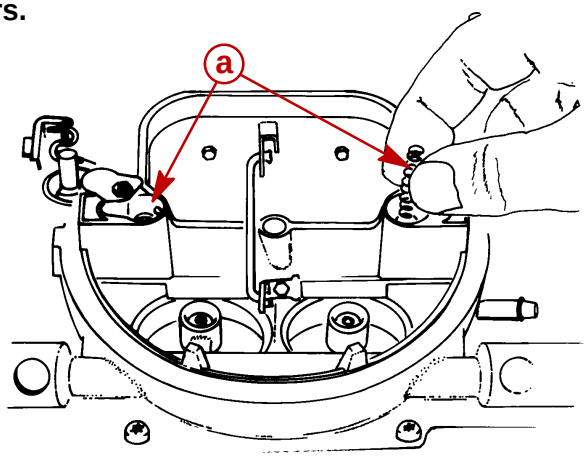


70396

a - Metering Rod Assembly(s)

5. Remove metering rod springs.

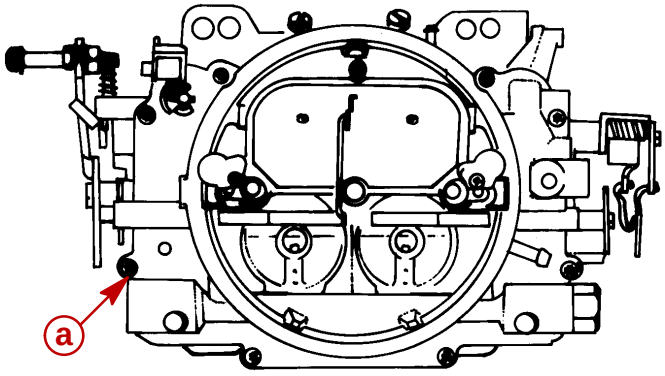
IMPORTANT: Metering rod springs are color coded and should not be interchanged with other carburetors.



70397

a - Spring(s)

6. Remove nine screws to separate top and bottom halves of carburetor.



70398

a - Screw(s)

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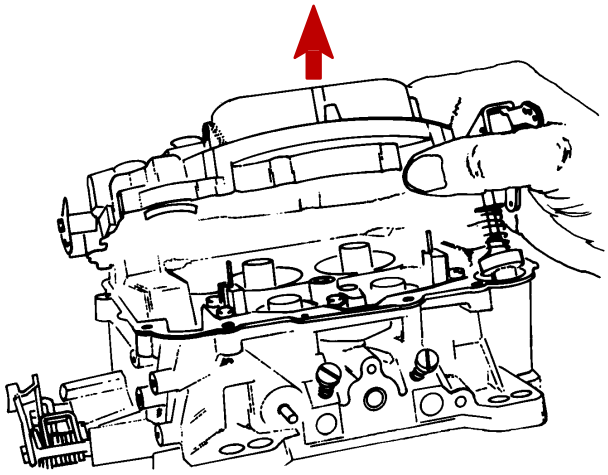
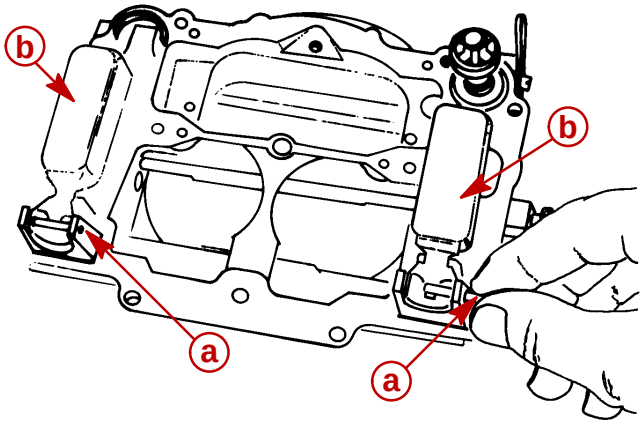
7. Carefully lift off carburetor top and disconnect choke linkage.



70399

8. Slide pin out to remove the float.

IMPORTANT: Be careful not to mix up floats after removal.

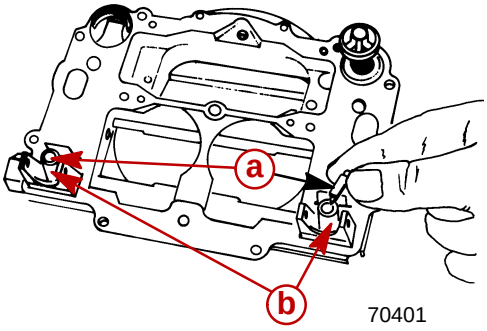


70400

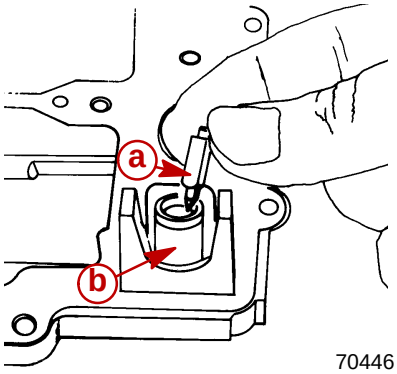
a - Pin(s)
b - Float(s)

9. Remove inlet needle from seat.

IMPORTANT: Be careful not to mix up inlet needles and seats after removal.



70401

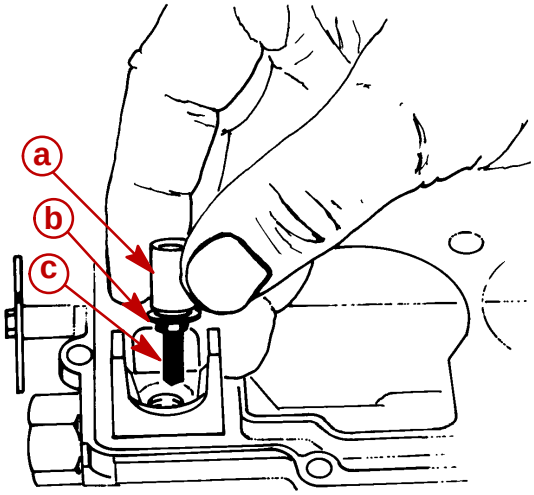


70446

a - Inlets Needle(s)
b - Seat(s)

10. Remove seat, gasket and inlet filter.

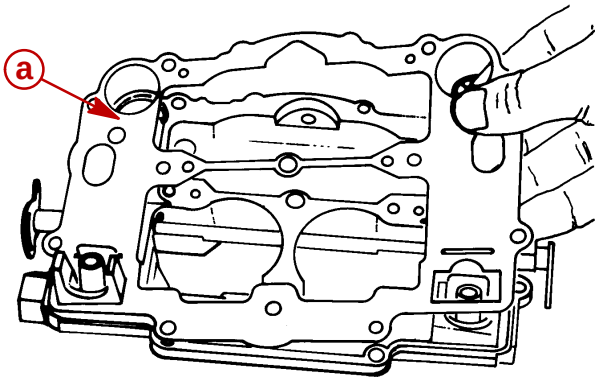
IMPORTANT: Be careful not to mix up seats after removal.



70447

a - Seat
b - Gasket
c - Inlet Filter

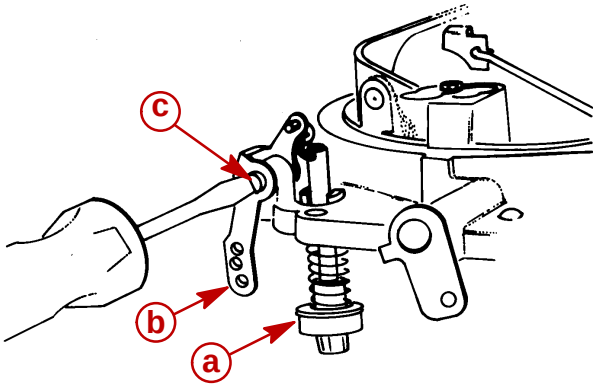
11. Remove gasket from top of carburetor.



70448

a - Gasket

12. Remove accelerator pump lever.

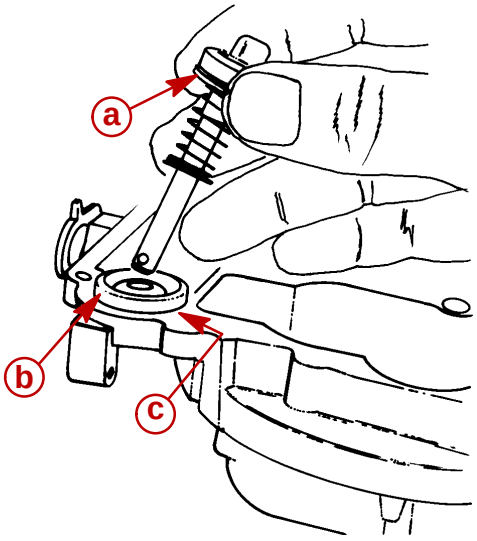


70449

a - Accelerator Pump
b - Accelerator Pump Lever
c - Retaining Screw

Index

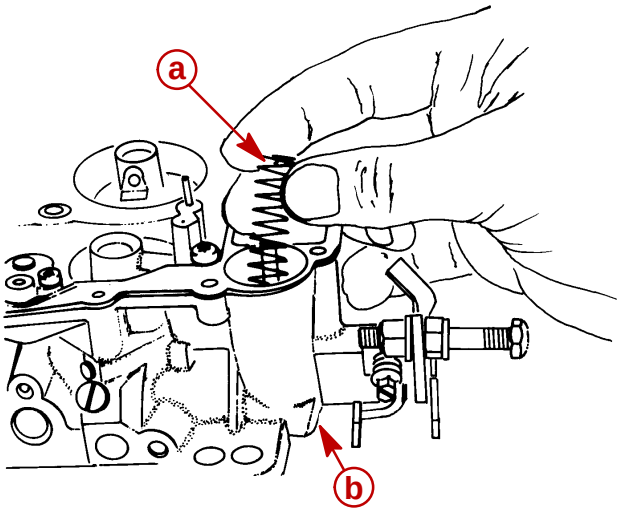
13. Remove accelerator pump.



70450

a - Accelerator Pump
b - Plunger Guide
c - Plunger Washer (Not Visible In This View)

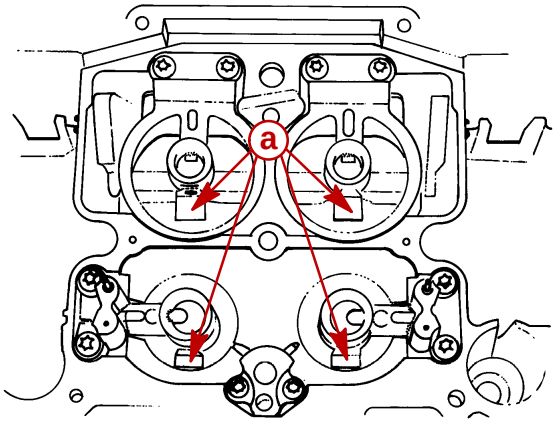
14. Remove accelerator pump spring from bottom half of carburetor.



70451

a - Accelerator Pump Spring
b - Carburetor Bottom

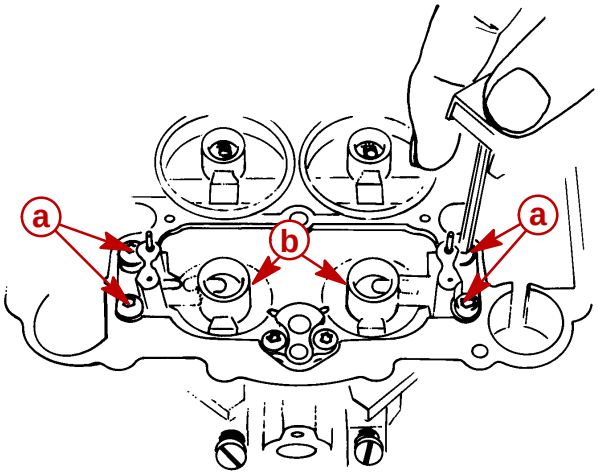
IMPORTANT: Before removing venturi clusters, it is important to note which clusters are equipped with a "distribution tab." This distribution tab arrangement varies from one carburetor to another.



70452

a - Distribution Tab(s) - Location And Total Number May Vary

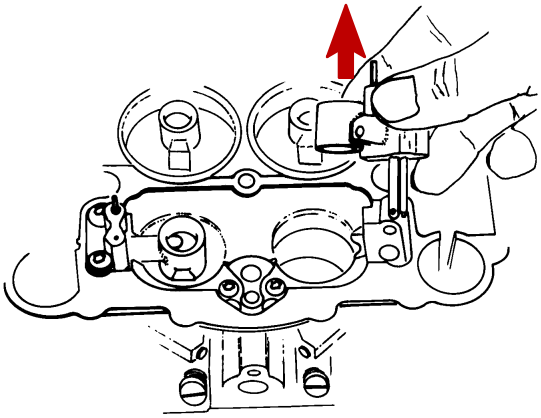
15. Remove two screws that secure primary venturi cluster.



70453

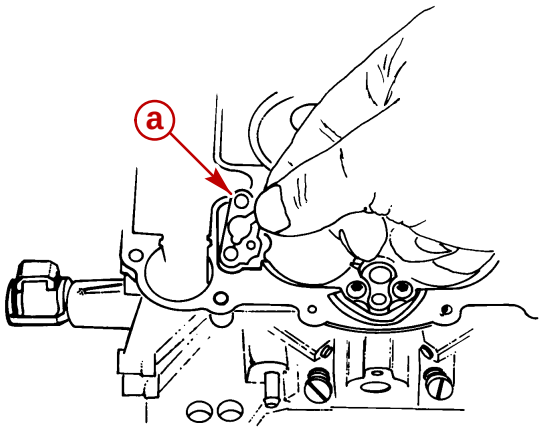
a - Screw(s) - Two On Each Side
b - Primary Venturi Cluster(s)

16. Remove primary venturi cluster by lifting straight up.



70454

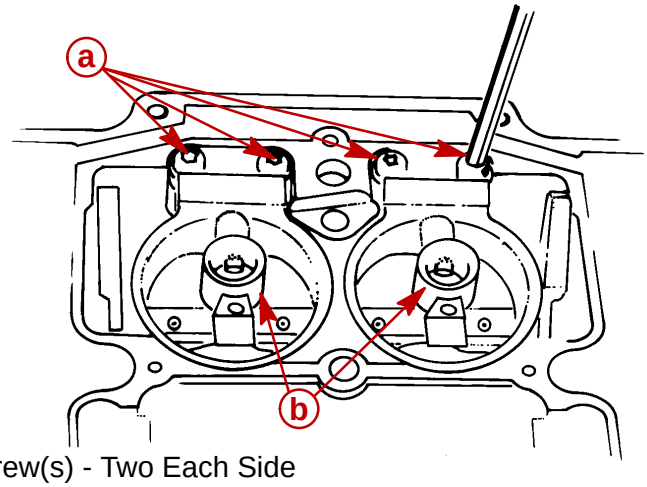
17. Remove gasket from beneath venturi cluster.



70455

a - Gasket, Primary Venturi Cluster

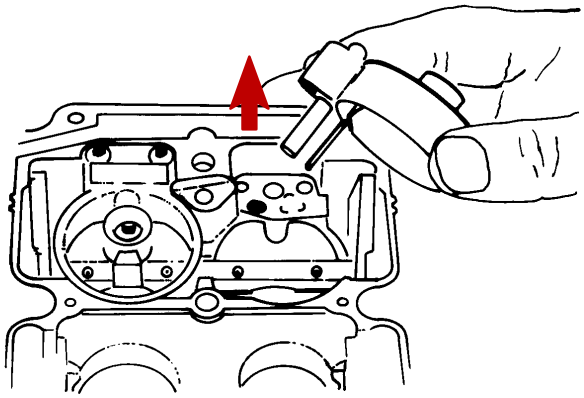
18. Remove two screws that secure secondary venturi clusters.



70456

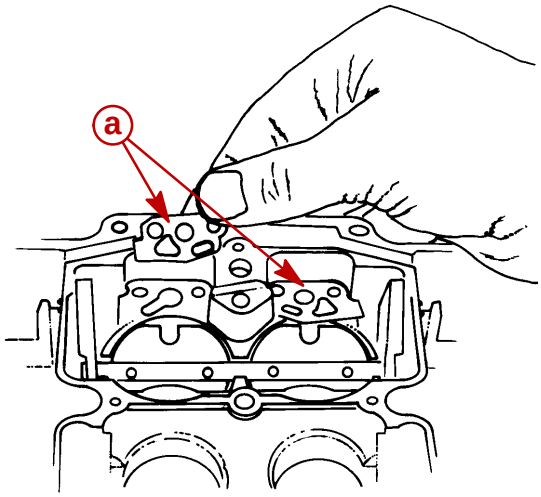
a - Screw(s) - Two Each Side
b - Secondary Venturi Cluster(s)

19. Remove secondary venturi cluster by lifting it straight up.



70457

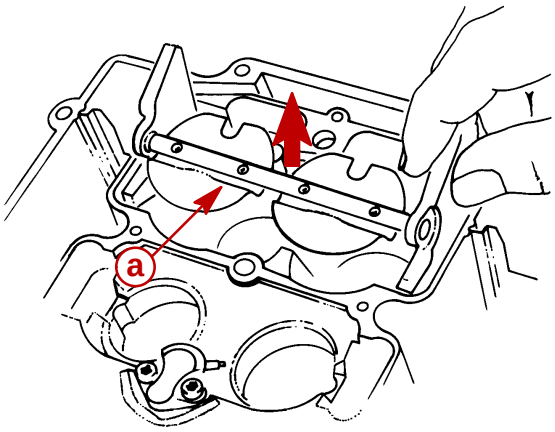
20. Remove gaskets from beneath secondary venturi clusters.



70458

a - Gasket, Secondary Venturi Cluster

21. Remove secondary air valve and weight assembly by lifting it straight out.

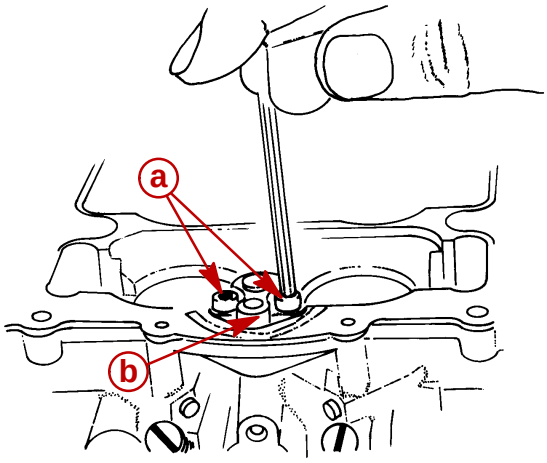


70459

a - Secondary Air Valve And Weight Assembly

Index

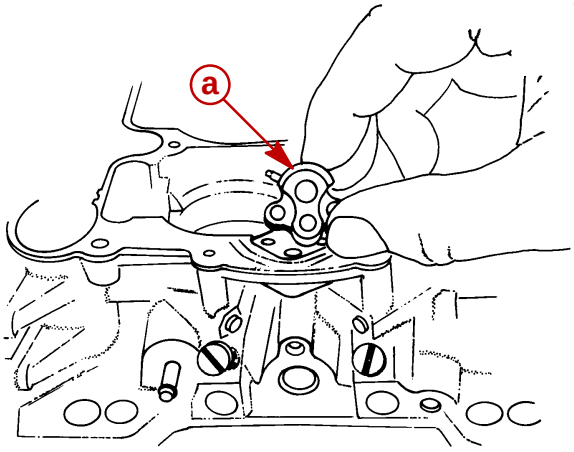
22. Remove two screws that secure pump jet housing.



70460

a - Screw(s)
b - Pump Jet Housing

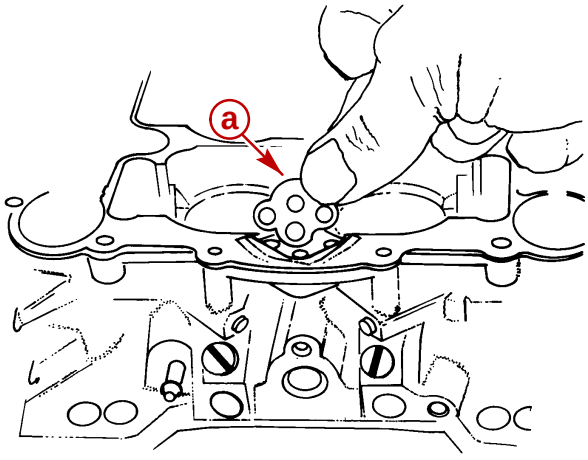
23. Remove pump jet housing.



70461

a - Pump Jet Housing

24. Remove gasket from beneath pump jet housing.



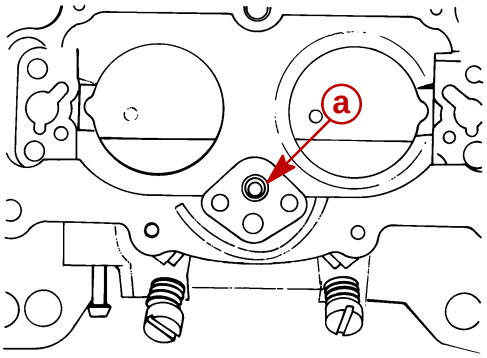
70462

a - Gasket, Pump Jet Housing

25. Remove check-ball and check-spring from hole beneath pump jet housing.

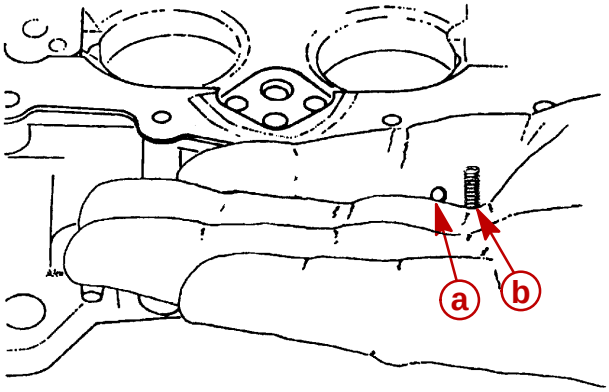
Index

IMPORTANT: Check ball spring is tapered. Ensure tapered end is down during reassembly.



70463

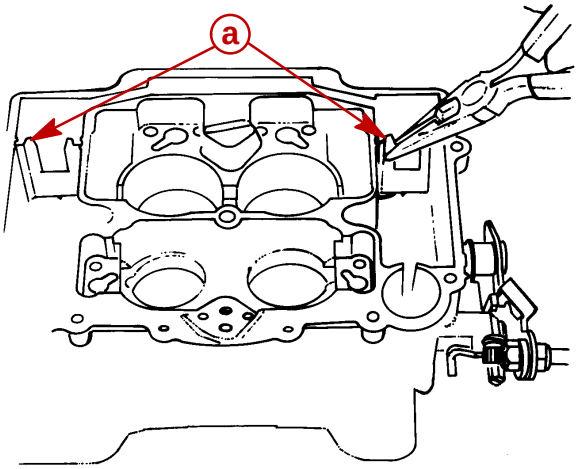
a - Ball Location



70464

a - Check Ball
b - Check Spring

26. Remove float bowl baffle plates, if necessary.



70465

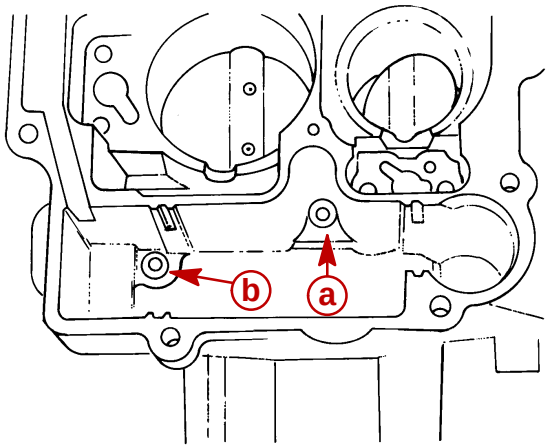
a - Baffle Plate

IMPORTANT: Do not mix up the primary and secondary jets. Make note of the jet sizes and their location before removal to be certain that during reassembly they are installed in the carburetor side from which they were removed.

NOTE: *If jets are difficult to remove, place a screwdriver of the correct width in the jet slot and lightly tap the end of the screwdriver with a hammer.*

Index

27. Remove primary and secondary jets.

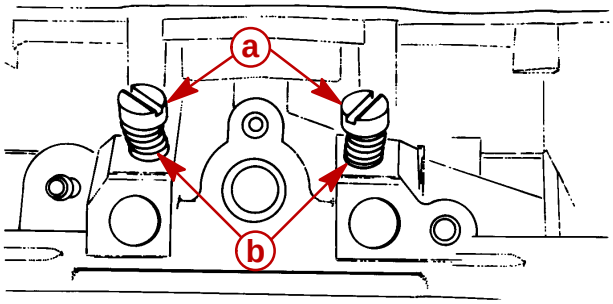


70466

a - Primary Fuel Jet
b - Secondary Fuel Jet

IMPORTANT: Before removing mixture screws, check and note the number of turns from the fully seated position. Do NOT mix up the two screws.

28. Remove mixture screws.



70467

a - Idle Mixture Screw
b - Spring, Idle Mixture Screw

Cleaning and Inspection

⚠ CAUTION

Rubber, plastic parts, pump plungers or diaphragms cannot be immersed in carburetor cleaner.

⚠ CAUTION

Avoid damage to carburetor. Do not leave carburetor in immersion-type cleaner for more than two hours.

IMPORTANT: Do not immerse metering rod springs in carburetor cleaner; the color, if not "natural" metal, may be removed. Clean separately as needed.

1. Clean metal carburetor parts in a commercial, immersion-type cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedures.

⚠ CAUTION

Avoid personal injury. Always wear safety glasses when using compressed air.

2. Blow out passages with compressed air. Do not drill through passages.

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

3. Wipe all parts that cannot be cleaned in immersion cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for damage or wear; pay particular attention to the following:
   a. **Idle mixture screws -** Replace if damaged or worn.
   b. **Fuel inlet needle valve and seat -** Replace with new needle and seat if worn or damaged.
   c. **Casting surfaces -** Inspect accelerator pump plunger well for scoring or deposits. Replace worn or corroded components.
   d. **All linkage rods and levers -** Replace if worn or damaged.
   e. **Accelerator pump and plunger parts -** Replace pump and parts if worn or damaged.
   f. **Float assembly and hinge pin -** Float weight of each should be the same. Replace either if fuel can be heard inside when shaken. Check hinge pin and holes for wear. Replace components if worn or defective.
   g. **Throttle valves and shafts -** Check for binding (through entire operating range, making sure valves open and close completely) or for looseness in carburetor body.

IMPORTANT: DO NOT remove throttle valves. If any of the throttle parts or float bowl/carburetor body shaft bores are found to be worn or damaged, carburetor replacement is required.

   h. **Choke valve and shaft/lever assembly -** Check shaft and lever for excessive looseness in air horn. Check choke valve and shaft/lever assembly for binding through entire operating range. Air horn assembly must be replaced if choke valve and shaft/lever are worn.

5. Check that choke pull-off diaphragm plunger retracts when vacuum is applied to unit, and that it holds vacuum (plunger remains seated if vacuum is maintained).

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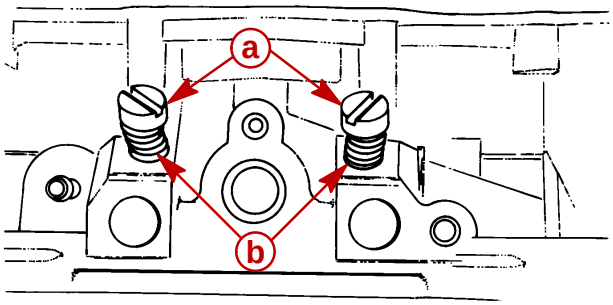
Reassembly

1. Install mixture screws (needles) with springs in place. Turn idle mixture screws in (clockwise) until LIGHTLY seated, then loosen 1-1/4 turns if previous settings were not noted on disassembly.

IMPORTANT: Do not turn idle mixture screws tightly against seat, as damage to seat and/or needle may result.

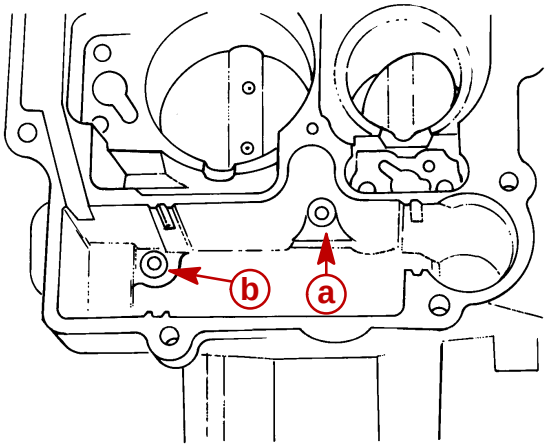


70467

a - Idle Mixture Screw
b - Spring, Idle Mixture Screw

2. Install the primary and secondary jets. Tighten securely.

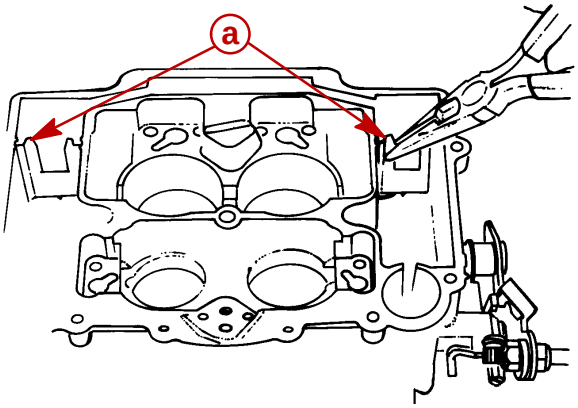
IMPORTANT: Be sure that primary and secondary jets are installed in the appropriate location. Be sure that the size matches the same size recorded during disassembly.



70466

a - Primary Fuel Jet
b - Secondary Fuel Jet

3. Install the float bowl baffle plates, if previously removed.



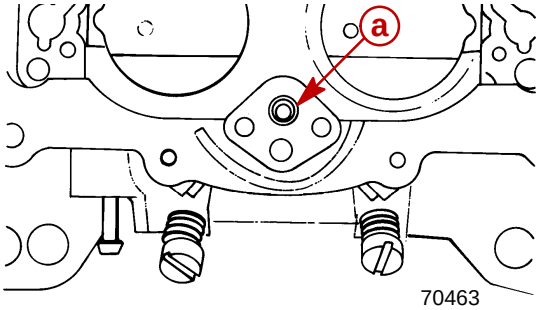
70465

a - Baffle Plate

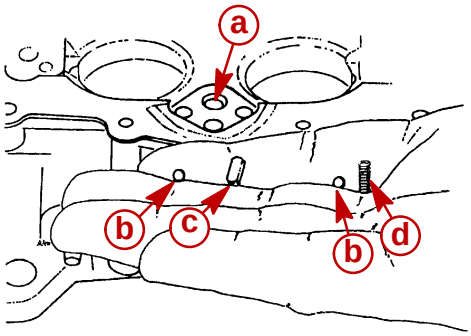
Index

4. Into bore beneath pump jet housing location, install check-ball and then check-weight or, if so equipped, check-ball and check-spring.

IMPORTANT: If your carburetor had a ball and weight combination, replace with ball and weight. If your carburetor used a ball and spring combination, replace with ball and spring.



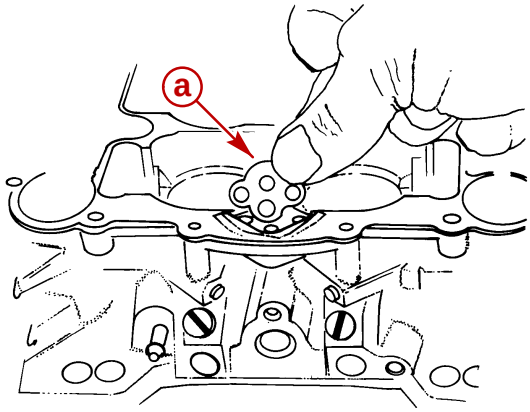
70463



70464

a - Bore
b - Check Ball
c - Check Weight
d - Check Spring

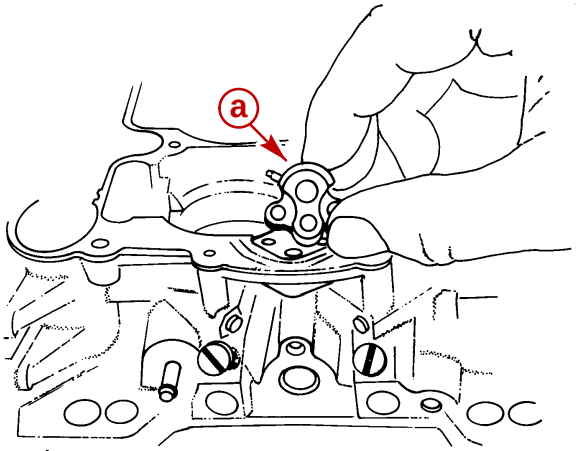
5. Position pump jet housing gasket.



70462

a - Gasket, Pump Jet Housing

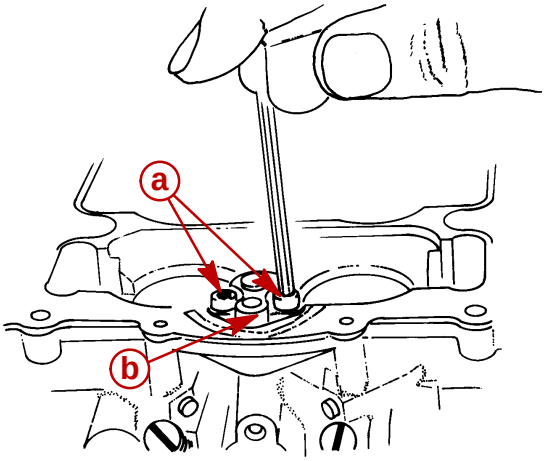
6. Install pump jet housing.



70461

a - Pump Jet Housing

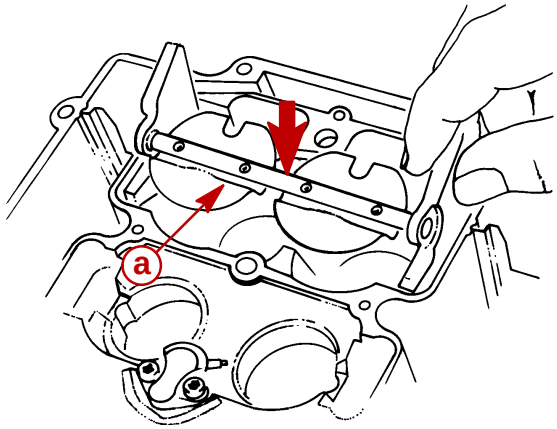
7. Install two screws that secure pump jet housing. Tighten securely.



70460

a - Screws
b - Pump Jet Housing

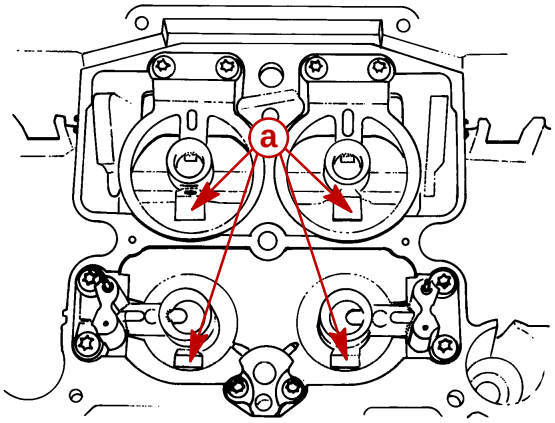
8. Install the secondary air valve and weight assembly.



70459

a - Secondary Air Valve And Weight Assembly

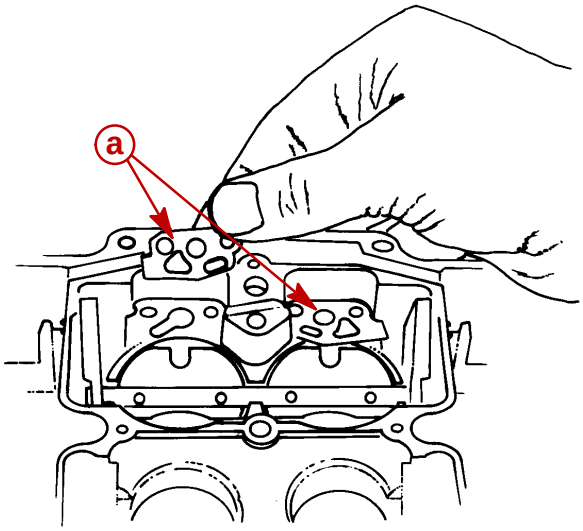
IMPORTANT: Before installing venturi clusters, it is important to note which clusters were equipped with a "distribution tab." This distribution tab arrangement varies from one carburetor to another.



70452

a - Distribution Tab(s) Location And Total Number May Vary

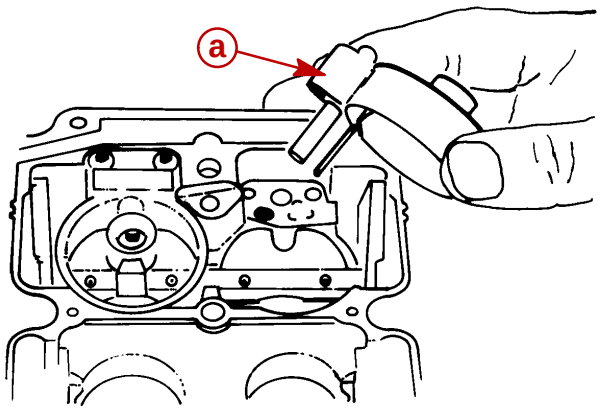
9. Position the secondary venturi cluster gaskets.



70458

a - Gasket, Secondary Venturi Cluster

10. Install the secondary venturi clusters.

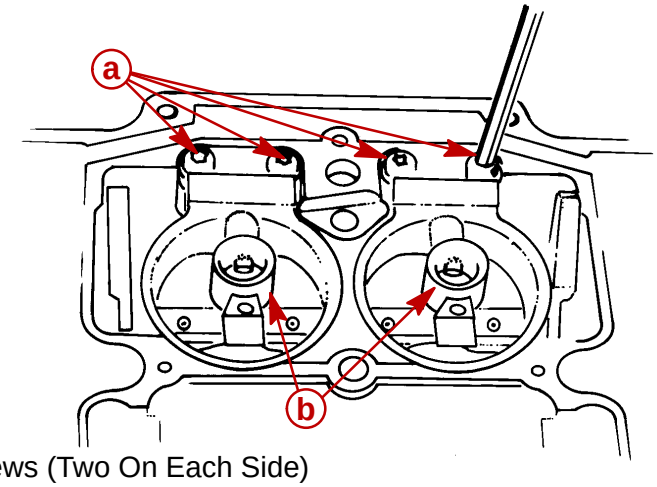


70457

a - Secondary Venturi Cluster

Index

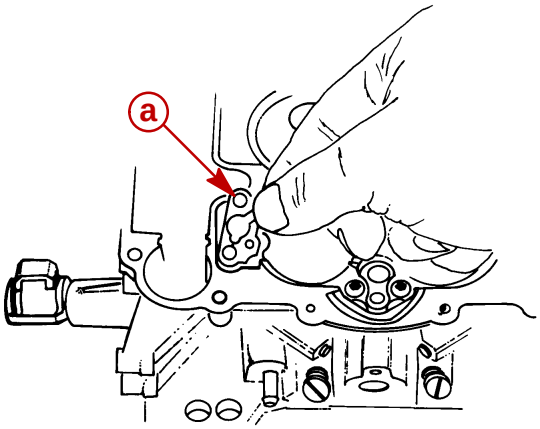
11. Secure each cluster with two screws. Tighten securely.



70456

a - Screws (Two On Each Side)
b - Secondary Venturi Cluster(s)

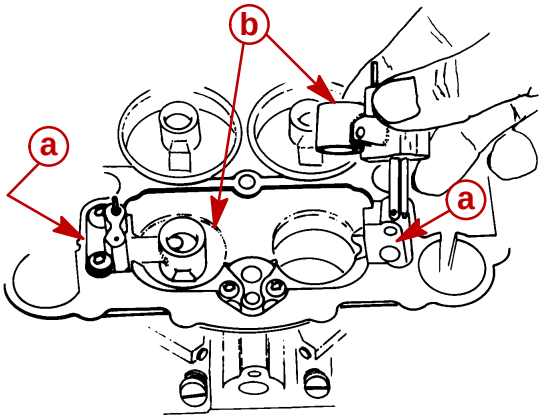
12. Position the primary venturi cluster gaskets.



70455

a - Gasket, Primary Venturi Cluster

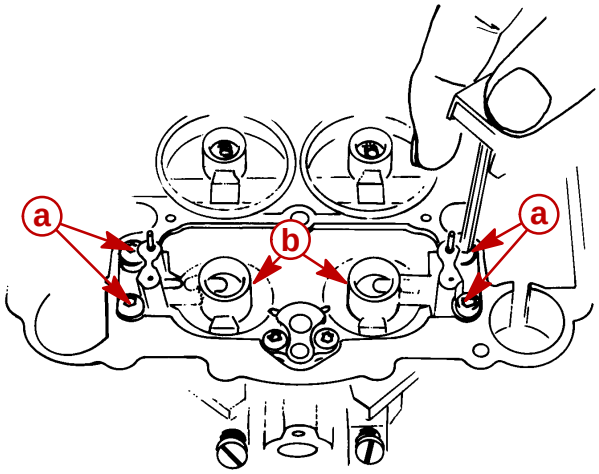
13. Install the primary venturi clusters.



70454

a - Gasket, Primary Venturi Cluster (One Not Visible In This View)
b - Primary Venturi Cluster

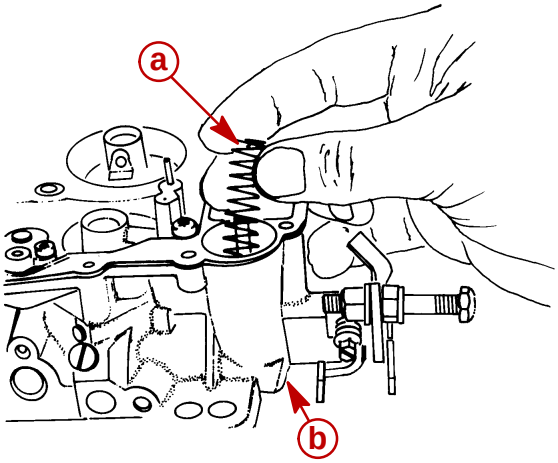
14. Secure each cluster with two screws. Tighten securely.



70453

a - Screws (Two Each Side)
b - Primary Venturi Cluster(s)

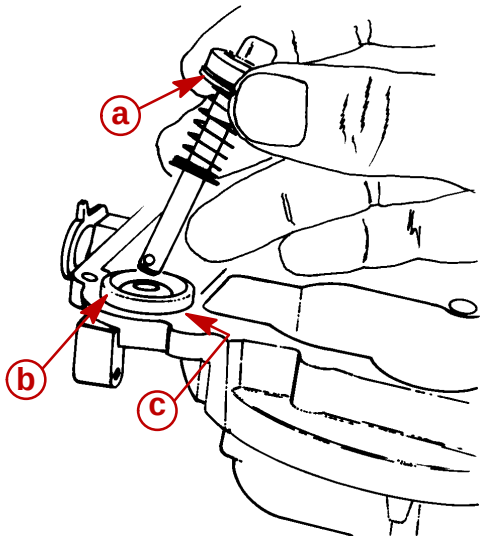
15. Install the accelerator pump spring into bottom half of carburetor.



70451

a - Accelerator Pump Spring
b - Carburetor Bottom

16. Install accelerator pump in top of carburetor housing, after placing washer and guide in position.

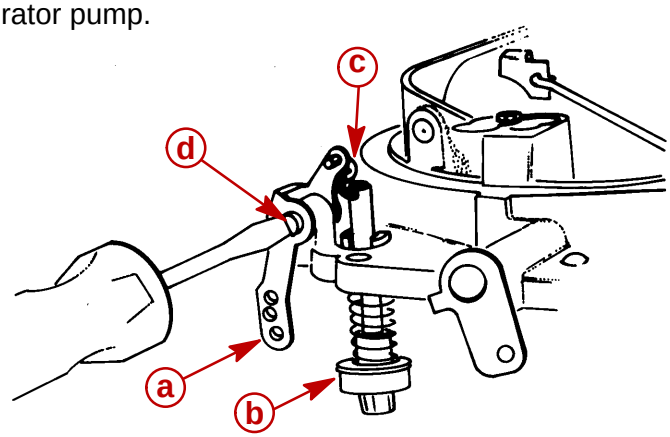


70450

a - Accelerator Pump
b - Plunger Guide
c - Plunger Washer (Not Visible In This View)

17. Connect accelerator pump lever to pump rod using the S-link.

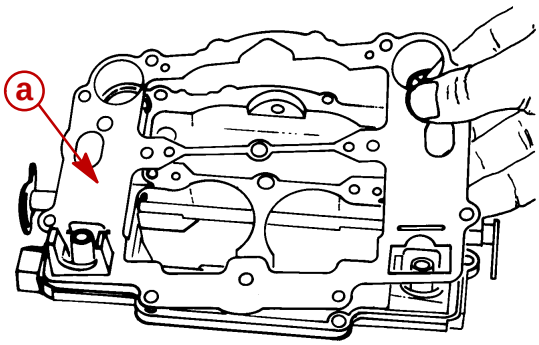
18. Secure pump lever with pivot screw. Tighten securely. Check to ensure lever actuates the accelerator pump.



70449

a - Accelerator Pump Lever
b - Accelerator Pump
c - S-Link
d - Retainer Screw

19. Install gasket on top of carburetor.



70448

a - Gasket

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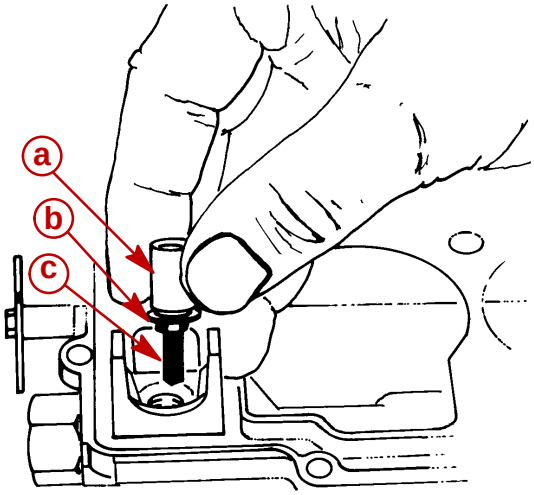
20. Install inlet filter in bottom of inlet seat.

21. Install inlet seat with gasket in place. Tighten securely.

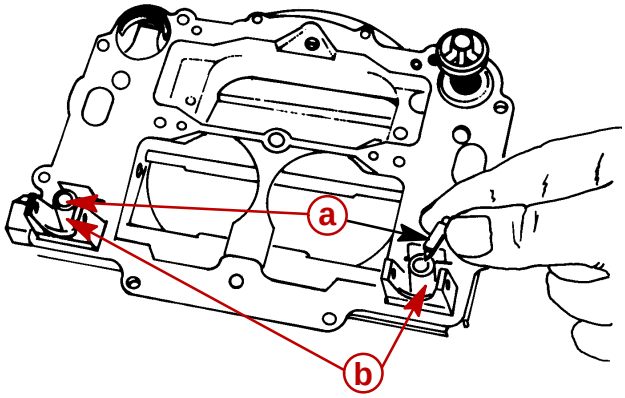


70447

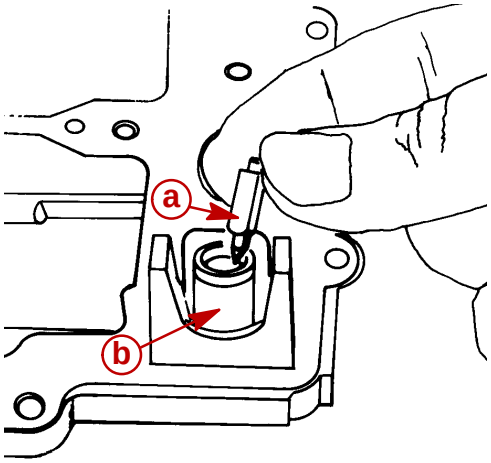
a - Seat
b - Gasket
c - Inlet Filter

IMPORTANT: If using existing needles and seats, be sure to reinstall them as matched sets, as noted during disassembly.

22. Install appropriate inlet needles into inlet seats.



70401



70446

a - Inlet Needle(s)
b - Seat(s)

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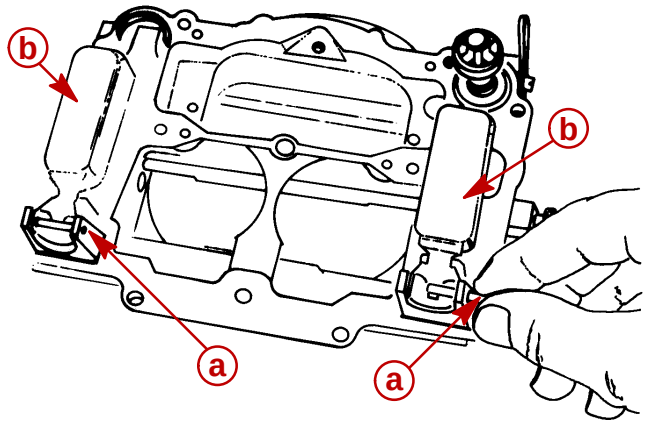
IMPORTANT: If using existing floats, be sure to reinstall them on the same side as removed.

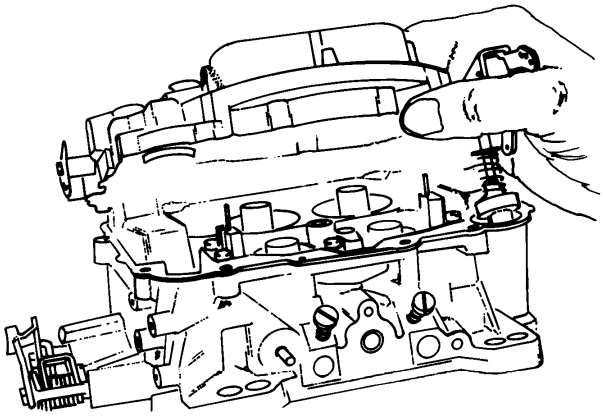
23. Install floats using hinge pins.



70400

a - Pin(s)
b - Floats(s)

24. Carefully lower top of carburetor onto bottom part.



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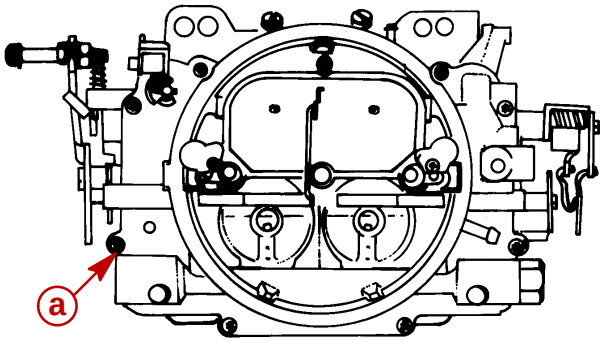
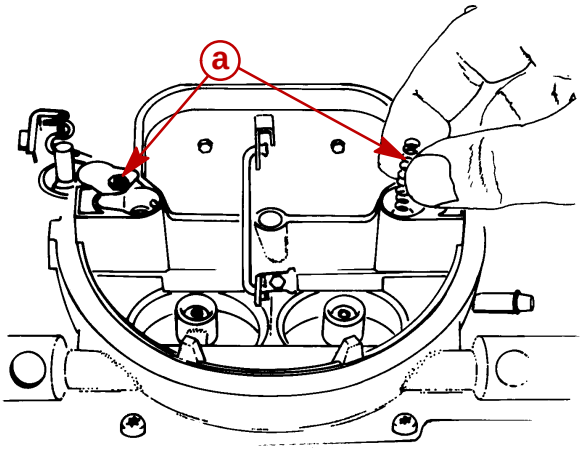
25. Ensure gasket is properly positioned between the two parts and secure the top to bottom with screws (nine total). Tighten securely.



70398

a - Screw(s)

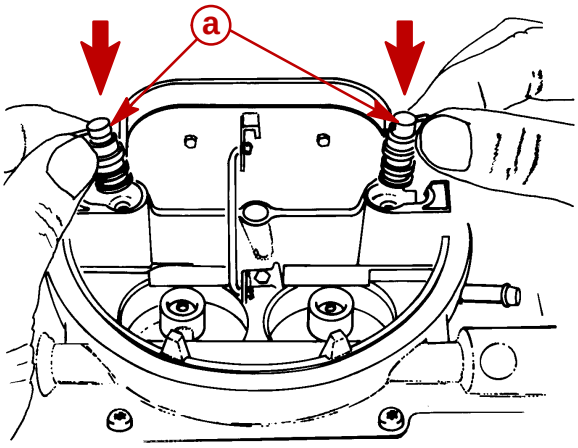


70397

a - Spring(s)

IMPORTANT: If using existing metering rods, be sure that they are reinstalled in the same side from which removed during disassembly.

26. Carefully install metering rod assemblies in the appropriate holes. Push down lightly on metering rods to ensure that plunger will spring up and down.



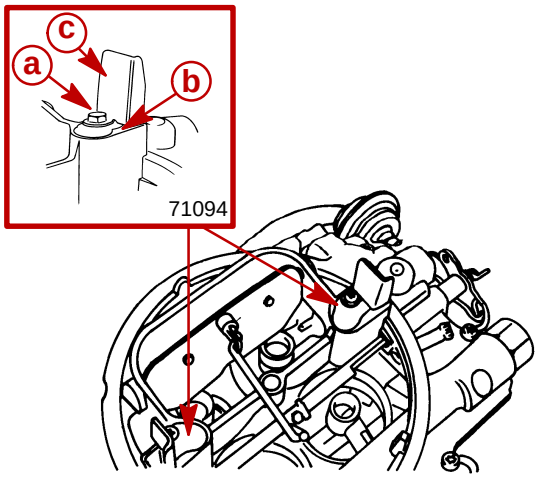
70396

a - Metering Rod Assembly(s)

IMPORTANT: Some carburetors are equipped with air deflectors that are attached to the screw that holds down the metering rod covers. Be sure to reinstall the deflectors if your model carburetor requires them.

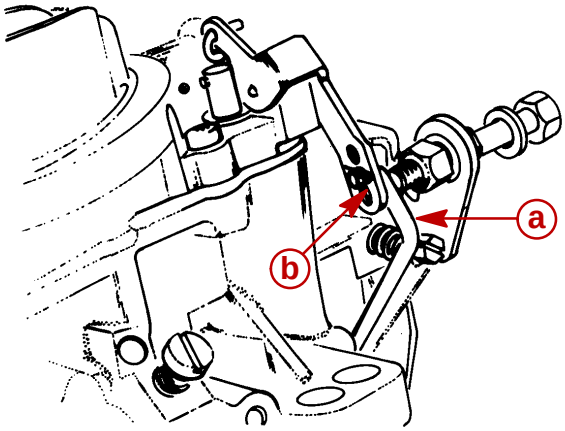
Index

27. Position metering rod covers (and air deflectors, if equipped) over metering rods and install screws. Tighten securely.



a - Screws
b - Metering Cover(s)
c - Air Deflectors (If Equipped)

28. Reconnect accelerator pump linkage rod to hole in accelerator pump lever where originally connected. Secure using wire clip.



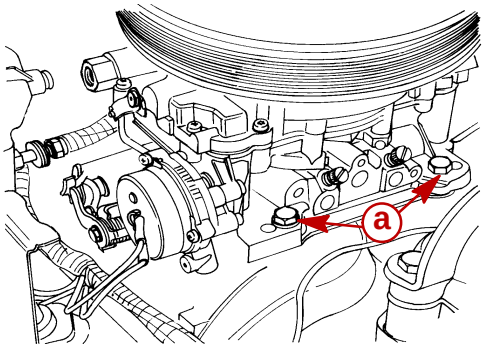
a - Accelerator Pump Linkage Rod
b - Wire Clip

29. Connect electric choke link rod to choke plate lever. Secure using wire clip.
30. Refer to “Installation” and install carburetor.

Installation

1. Place appropriate new gasket on intake manifold.
2. If equipped, install adaptor or wedge plate, depending on model. Place appropriate new gasket on top.

3. Install carburetor and throttle bracket with attaching hardware. Torque fasteners to 132 lb-in. (15 Nm).



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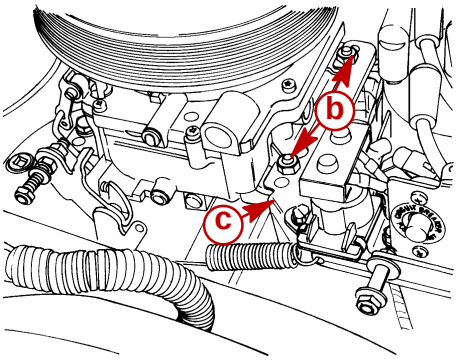
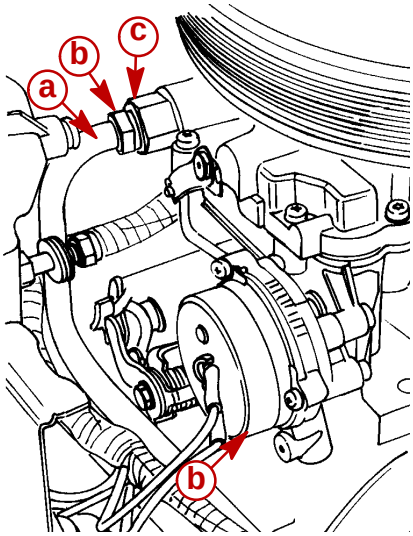


75863

a - Fuel Line
b - Attaching Hardware
c - Throttle Bracket

4. Install fuel line. To prevent over-tightening, hold fuel inlet filter nut with suitable wrench and tighten fuel line connector securely.



75862

a - Fuel Line
b - Fuel Line Connector
c - Fuel Inlet Filter Nut

5. Refer to SECTION 2. **Install and adjust** throttle cable following instructions appropriate to your power package.
6. Install flame arrestor and tighten nut securely.
7. Installing positive battery cable to positive (+) battery terminal. Tighten clamp securely.
8. Install negative battery cable to negative (–) battery terminal. Tighten clamp securely.
9. Turn on fuel supply at fuel tank.
10. Start engine and check for gasoline leaks. If leaks exist, **STOP ENGINE IMMEDIATELY** and recheck connections.
11. Adjust idle speed and idle mixture, as previously outlined under “Adjustments.”

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FUEL SYSTEM

Section 5D - Sav1 Emission Fuel System With Weber 4 Barrel Carburetor

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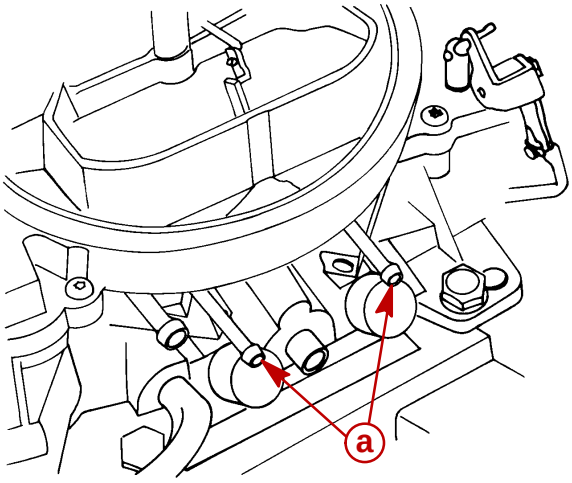
5 D

Identification

The SAV1 Emissions version of the Weber WFB carburetor has vacuum fittings on the front side.



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a - Vacuum Fittings

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your Mercury MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Carburetor to Manifold	132		15
Fuel Line to Carburetor		18	24
Fuel Inlet Filter Nut		18	24

Special Tools

Mercury Marine Special Tools	
Description	**Part Number**
Universal Carburetor Gauge	91-36392
Tachometer	91-59339

Index

Other Special Tools	
Description	**Part Number**
Universal Carburetor Stand	Obtain Locally
TORX® Screwdrivers (15, 20 & 25)	
Propane Bottle [14 oz. (400 grams)]	
Propane Enrichment Kit (Various Suppliers)	(1) J26911 (2) YA7148 (3) 7148
Ported Vacuum Switch (PVS) Socket Wrench (Various Suppliers)	(1) No P/N (2) S9842A (3) 7267

Special Tool Suppliers:
(1) Kent-Moore Part Number
(2) Snap-On Part Number
(3) OTC Part Number

NOTE: *Weber carburetors will have a "star" shaped socket in the head of some screws. A TORX® screwdriver must be used on this type of screw. The sizes used are numbers 15, 20 and 25.*

Engine Specifications

Model	MCM 4.3LH
Thermostat	160°F (71°C)
Ignition Timing	10° BTDC
Idle Speed in Neutral	775 rpm
Propane Idle Speed (See Procedure)	850 rpm

Carburetor Specifications

NOTICE
Unit Of Measurement: U.S. Inches (Millimeters)
All measurements are +/– 1/64 in. (0.4 mm)

Engine Model	Carb Type	Mercury Number (Manufacturer Number)	Primary Jet Size	Secondary Jet Size	Metering Rod Number	Metering Rod Spring Color
MCM 4.3LH	Weber WFB	3310-860076 (9667S)	.087 (2.21)	.086 (2.18)	16-656457	Natural

Carburetor Adjustment Specifications

Make And Model	Weber WFB
Float Level	1-9/32 (33)
Float Drop	2 In. (51)
Pump Rod Hole Location	Number 3 from end (Hole closest to lever pivot point)
Accelerator Pump	7/16 (11) (Note 1)

NOTE: *Measured from top of Carburetor to bottom of S-Link*

Description

The Emissions system is designed to lower exhaust emissions to meet regulations. It consists of the following items: a Positive Crankcase Ventilation (PCV) circuit, a Ported Vacuum Switch (PVS) circuit and a specially designed Weber WFB carburetor.

Weber WFB carburetor is unique in design, as the main body and flange are cast as a one piece unit. This, along with the bowl cover, make up the two piece construction which is made of light, durable aluminum to dissipate heat.

There are two separate float circuits. Each float circuit supplies fuel to a primary low speed circuit and a primary and secondary high speed circuit. The bowls are vented to the inside of the air horn. A connecting vent passage effects a balance of the air pressure between the two bowls.

The float needle valves are installed at an angle to provide the best possible seating action on the needles. This provides better needle response to float movement, also.

The PVS circuit is used in conjunction with the idle circuit. When the engine is cold, the PVS circuit is closed. This shuts off a metered air-bleed to the idle circuit, to maintain a rich idle circuit for warm-up. Once the engine warms up [approximately 128°F (54°C)], the PVS opens, allowing a metered amount of air to be mixed into the idle circuit. This leans the idle circuit to the proper operating air-fuel ratio.

The high speed circuits use staged step-up rods in the main metering jets to control the amount of fuel admitted to the nozzles. The position of the step-up rod is controlled by manifold vacuum applied to the vacuum piston.

A primary air bleed located in the venturi cluster prevents a rich condition or bog as the high speed circuit is reactivated after deceleration.

Small “L” shaped metal tabs, called “distribution tab(s),” are attached to some venturi clusters and protrude into the air stream at the proper location to aid distribution of fuel on selected applications.

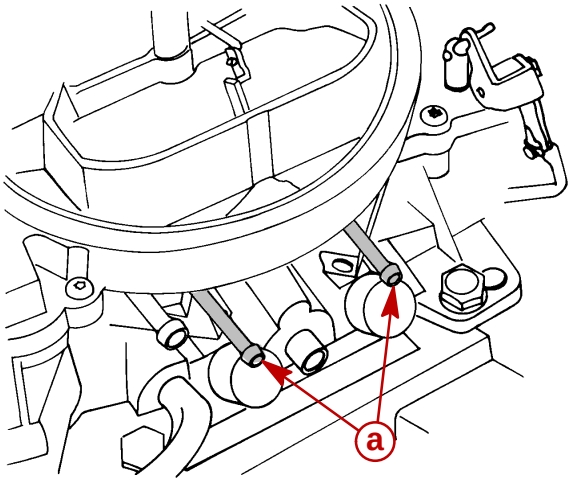
The PCV circuit ventilates crankcase vapors (unburned gases) back into the intake manifold to be burned again.

Special Notes

IMPORTANT: Disassembly and repair of the SAV1 Emissions carburetor is basically the same as the other Weber WFB carburetors. There are some internal and external differences that are noted following:

Carburetor Top Cover

The carburetor top cover (air-horn) has vacuum fittings for connection to the “Ported Vacuum Switch” (PVS).



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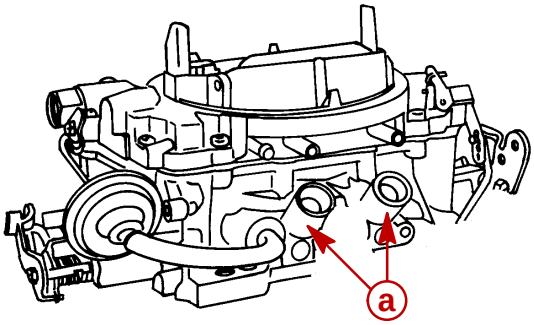
a - Vacuum Fittings

Sealed Idle Mixture Screws

The idle mixture screws have seals that prevent tampering with the idle mixture after the mixture has been properly adjusted.



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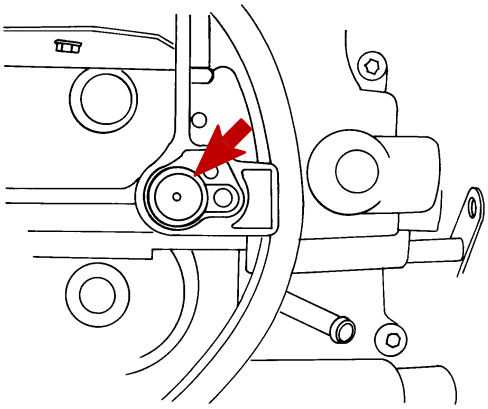
Typical

a - Screw Seals

Piston Bore of Emissions Model

The piston bore of the Emissions Model of the Weber carburetor has a machined step as shown.



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Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist, before closing engine hatch.

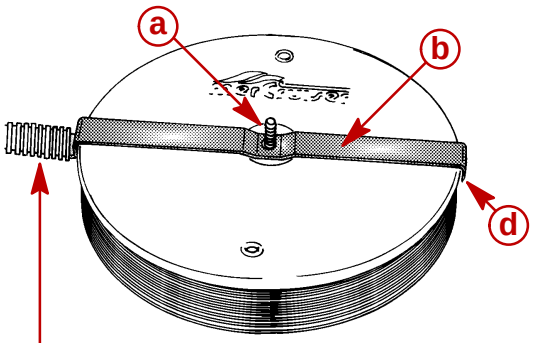
⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing or water pickup inlet, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Maintenance

Flame Arrestor

Maintenance for the flame arrestor is the same as standard engine (Refer to SECTION 5C). The only difference in the flame arrestor on an engine with the Bodensee Emissions system is in the vent hose bracket. This bracket has a fitting on one side only.



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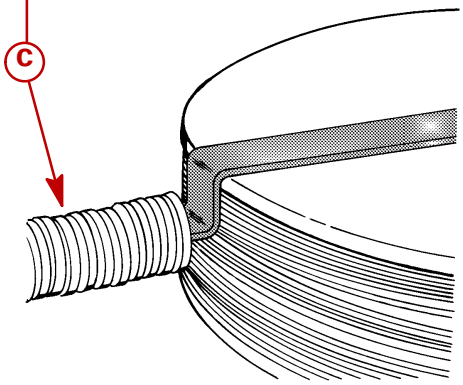


71797

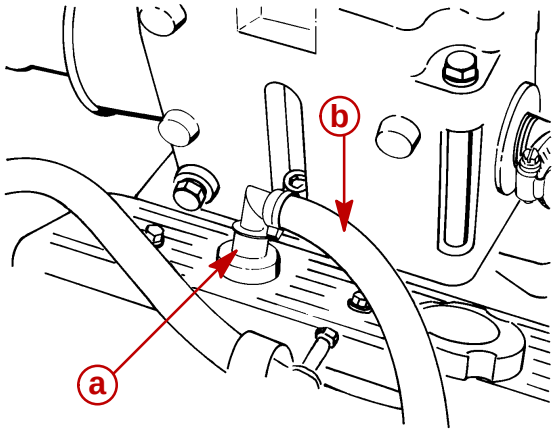
a - Stud
b - Vent Hose Bracket
c - Vent Hose To Starboard Valve Cover
d - NO VENT HOSE ON THIS SIDE

Fuel Filter

Maintenance for fuel inlet filters is the same as standard engine (See SECTION 5C.).

Positive Crankcase Ventilation (PCV)

The Positive Crankcase Ventilation (PCV) valve should be replaced once a year.



71925

Typical

a - PCV Valve
b - Hose

Troubleshooting

NOTE: *Review the "Description" section of this manual for an understanding of system operation, before troubleshooting the carburetor. Do not assume that a problem exists inside the carburetor without first eliminating other engine system components as potential problem areas. Be sure to check the following items:*

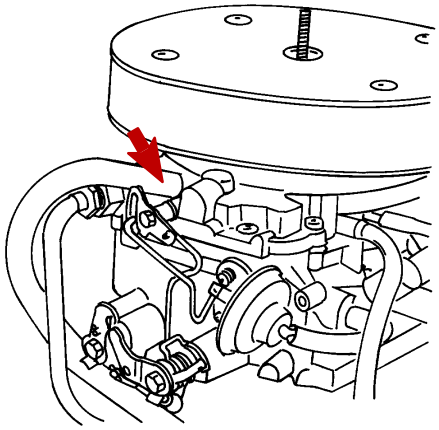
- Engine operating temperature (Proper Thermostat - See "Engine Specification Chart").
- Correct ignition timing (See "Engine Specification Chart").
- Cylinder compression.
- Ported Vacuum Switch (PVS) functioning properly.

Use the following procedure to check for a faulty Ported Vacuum Switch (PVS):

Checking Ported Vacuum Switch and Carburetor Vacuum Circuit for Correct Operation

NOTE: *The engine must be cold before performing the first 4 steps.*

1. Start engine. Disconnect the hose from the carburetor at the location shown.



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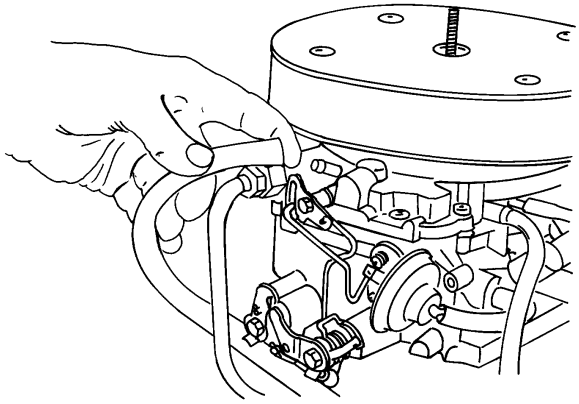
2. Plug the hose with your finger. You should not feel vacuum on the hose at this time.



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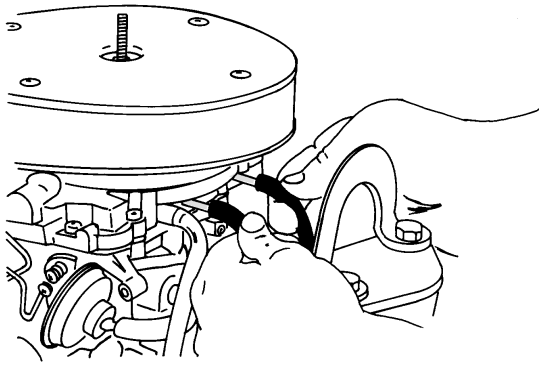
3. Allow engine to run and warm up to normal operating temperature.
4. Disconnect the hose again and check for vacuum. If PVS is functioning properly, there should be vacuum present at this time. If vacuum is not present, ensure that hoses are properly connected and are not cracked or plugged.
5. Proceed to check the carburetor vacuum circuit.
6. Reconnect rear hose to carburetor.

NOTE: *The engine must be warm before performing the next step.*

7. Start engine and allow it to reach normal operating temperature.

8. Disconnect the two hoses on the front of carburetor.



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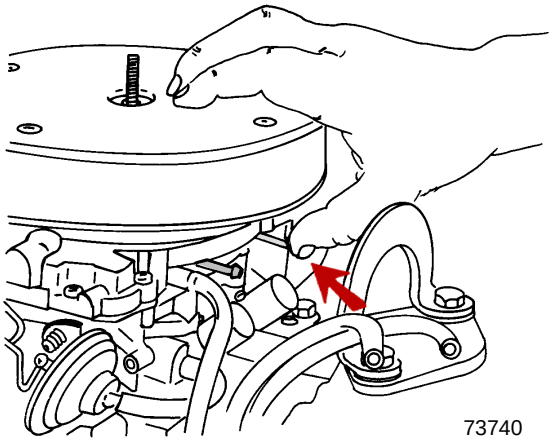
IMPORTANT: Ensure that engine is running at 775 rpm or below. This ensures that the carburetor is not running on the “Off-Idle” circuit.

9. Connect a tachometer to the engine.
10. Plug the vacuum ports on the front of the carburetor. Be sure to only plug one port at a time. When vacuum port is covered, the engine rpm should increase.
11. Repeat test on the other port. If vacuum is not present, a vacuum port may be plugged. Clean vacuum ports and repeat the entire test.



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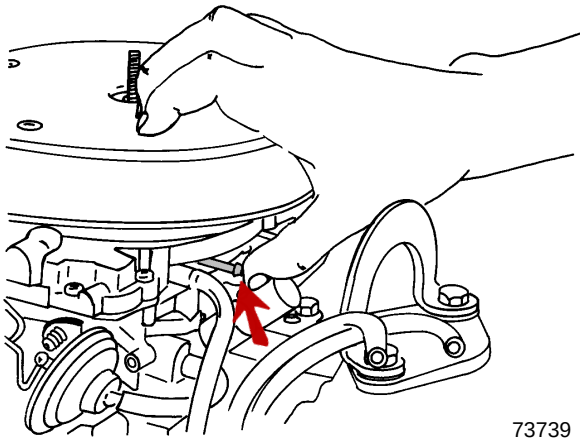

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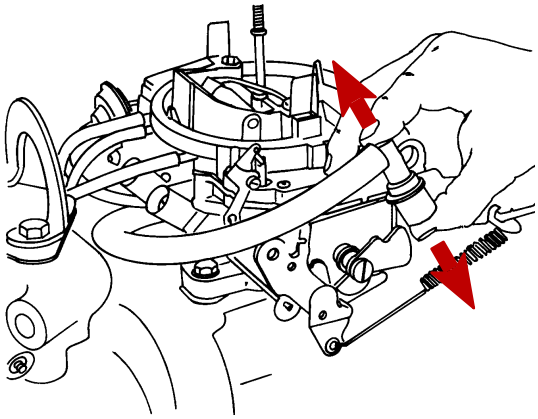
12. When test is complete and PVS is determined to be functioning properly, reconnect all hoses in vacuum circuit.

Service Procedures

Checking Positive Crankcase Ventilation (PCV) Valve

1. Start engine and allow it to reach normal operating temperature.
2. Remove PCV valve from valve cover. Plug the opening with your finger. A vacuum should be felt.
3. Stop the engine.
4. Shake the valve to ensure that the internal components are free to move.



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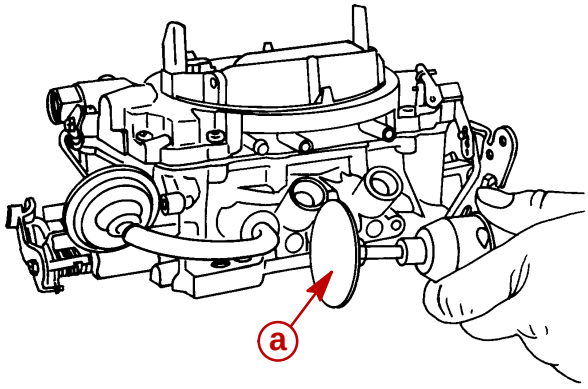
Removing Seals From Idle Mixture Screws

⚠ WARNING

Avoid fire or explosion. Using a cutting wheel to cut the seals will cause sparks, which will ignite any fuel that is present. Ensure that there is no fuel present and that carburetor is removed from engine prior to cutting the seals from the carburetor idle mixture screws.

1. Remove carburetor from the engine.
2. Drain all fuel from the carburetor.
3. Using a cutting wheel, make a cut on both sides of the seal casing.
4. Using a suitable device, pry the plug from the inside of the seal. Once the plug is removed, the idle mixture screw can be removed and the seal casing can be removed.



73744

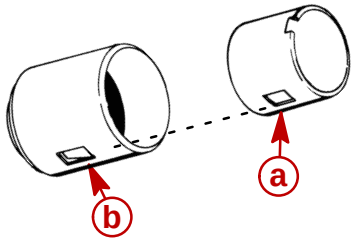
a - Cutting Wheel

Installing New Seals

1. Install new seal cup, spring and idle mixture screw.

IMPORTANT: Do not install the seal plug until the "Propane Assisted Idle Mixture Adjustment" procedure has been completed.

2. Align the opening in the plug with the tab on the cup and push down until it snaps in place.

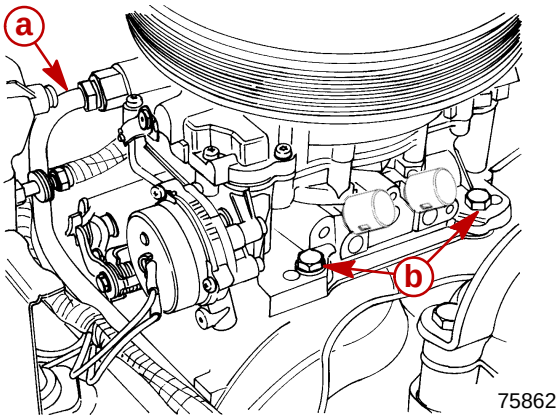


73789

a - Opening In Plug
b - Tab On Cup

Carburetor Installation

1. Place new gasket on adapter plate.
2. Install carburetor and throttle bracket and secure with new attaching hardware. Torque fasteners to 132 lb-in. (15 Nm).
3. Connect fuel line. To prevent over-tightening, hold fuel inlet nut with a suitable wrench and tighten fuel line connector securely.



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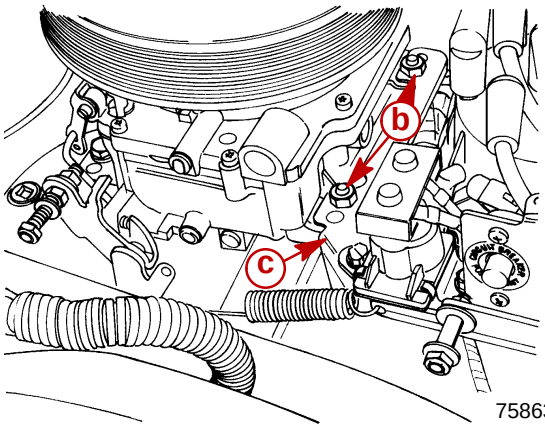
Weber 4 Barrel
Starboard Front



75863

Weber 4 Barrel
Starboard Rear

a - Fuel Line
b - Attaching Hardware
c - Throttle Bracket

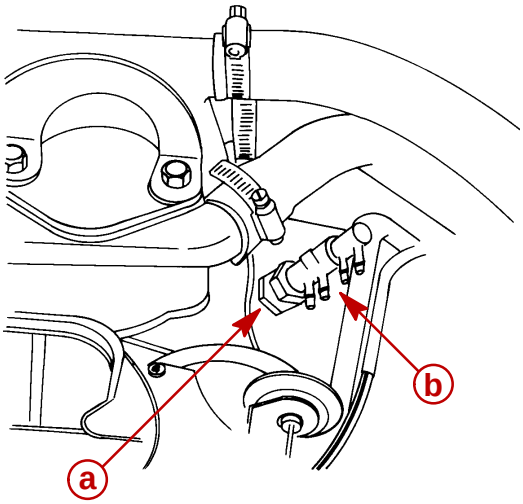
Ported Vacuum Switch Installation

⚠ CAUTION

Be careful not to break off fittings when installing the ported vacuum switch (PVS) in the following step.

NOTE: *A special tool is available to install the PVS. Refer to the "Tool Chart" at the beginning of this manual.*

1. If removed, install ported vacuum switch (PVS) into reducer bushing. Apply Loctite Pipe Sealant with Teflon to threads before installing. Tighten PVS securely and position the fittings toward back of engine as shown.

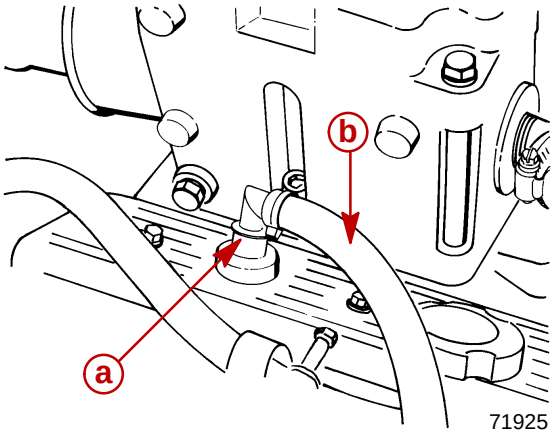


71913

a - Reducer Bushing
b - Ported Vacuum Switch (PVS)

Emissions System Connections

1. Install the positive crankcase ventilation (PCV) valve in the port valve cover.
2. Connect hose to PCV valve. Connect opposite end of hose to fitting on front of carburetor.



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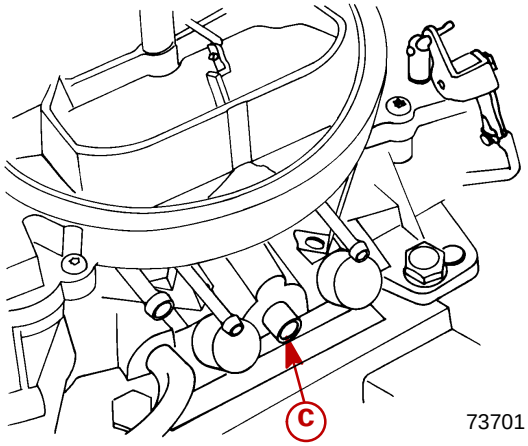

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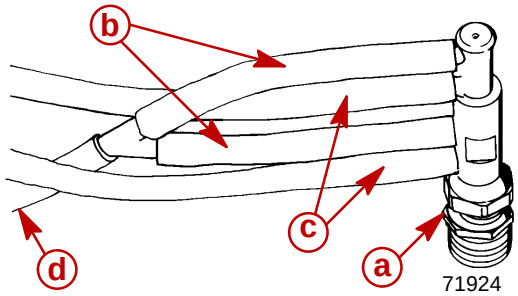
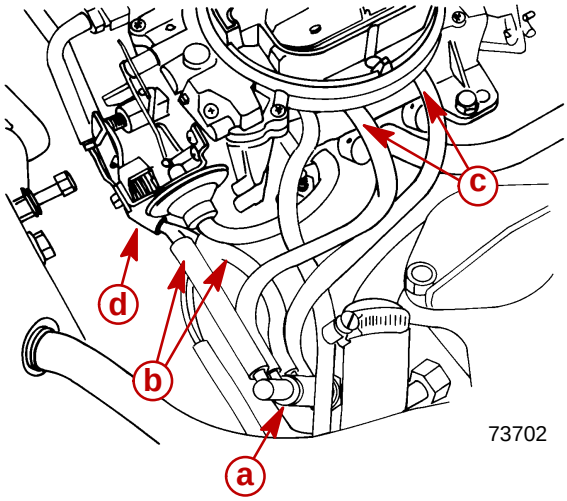
a - PCV Valve
b - Hose
c - Carburetor Fitting (Connect Hose Here)

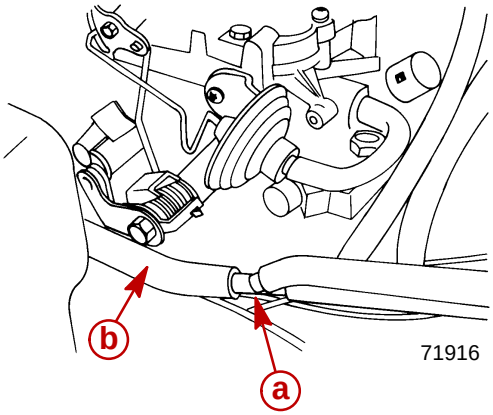
3. Connect hoses to ported vacuum switch (PVS) as shown.

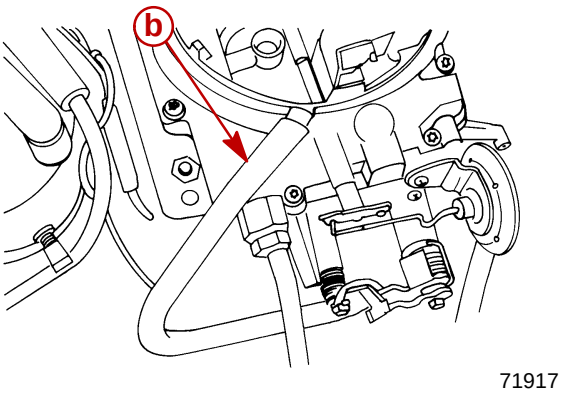




a - Ported Vacuum Switch
b - Hoses (Switch To Y-Fitting)
c - Hoses (To Front Side Of Carburetor)
d - Hose (Y-Fitting To Back Side Of Carburetor)

IMPORTANT: The hose that runs from the T-Fitting to the back side of the carburetor must be routed beneath the throttle linkage as shown in the following illustration. Ensure that the hose does not rub against linkage.





a - T-Fitting
b - Hose, T-Fitting To Back Of Carburetor

Propane Assisted Idle Set Procedure

⚠ WARNING

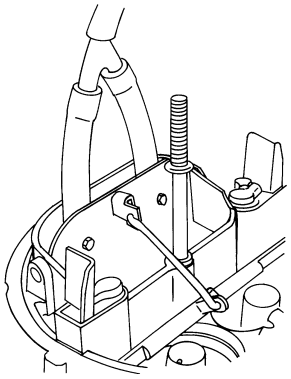
Avoid fire or explosion. Observe the following precautions when performing this procedure.

- **Do not operate the engine without the flame arrestor installed, above the speeds listed in this procedure.**
- **Propane is extremely flammable and explosive. Ensure that the following test is performed in a well ventilated area with the engine hatch open.**
- **Ensure that there is no spark or open flame in the test area.**
- **Do not start the flow of propane until the hose has been placed into the carburetor and the engine has been started.**
- **Keep a fire extinguisher available when performing this test.**

NOTE: *This test must be performed any time the carburetor has been disassembled and internal components have been disturbed or the idle mixture screws have been tampered with. The test should also be performed if other component parts of the emissions system have been altered, repaired or replaced.*

IMPORTANT: Ensure that the PVS is functioning properly before performing this procedure.

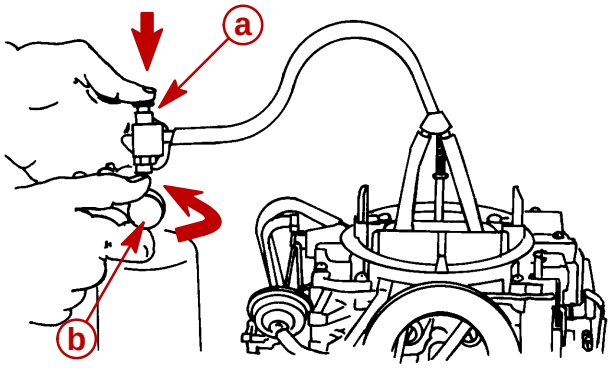
1. As a starting point, set both idle mixture screws at 1 turn out from the fully seated position.
2. Start engine and allow it to warm up to normal operating temperature. If engine has been run above idle speed, allow engine to idle for 3 to 5 minutes to stabilize the engine.
3. Remove flame arrestor.
4. Insert special “Y”-Adapter hoses into carburetor as shown. Place the hoses behind the choke plate to help hold them in place.



73731

5. Connect the hose from the propane bottle valve to the “Y”-Fitting.

6. With engine idling at normal operating temperature, press the propane flow button on the valve. Slowly begin opening the propane metering valve until maximum engine rpm is reached. When too much propane is added, engine rpm will decrease. “Fine tune” the metering valve to obtain the highest rpm.



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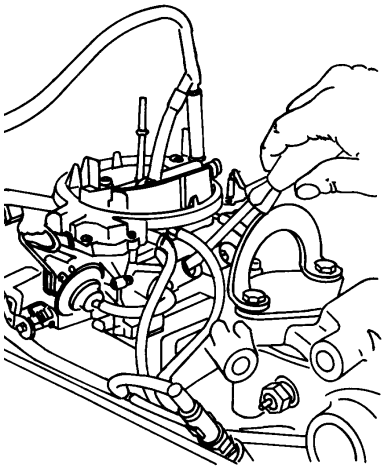
a - Propane Flow Valve
b - Propane Metering Valve

7. With propane still flowing, adjust the idle speed screw (not the mixture screws) to obtain 850 rpm. Again, fine tune the propane metering valve to obtain the highest engine rpm. If there has been a change in the maximum rpm, readjust the idle speed screw to 850 rpm.
8. Release the propane flow valve and allow engine speed to stabilize. Slowly adjust the mixture screws by equal amounts, pausing between adjustments to allow engine speed to stabilize, to achieve 775 rpm.



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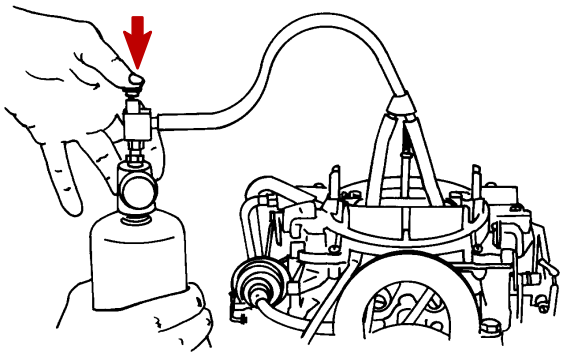
9. Press the propane flow valve. Engine rpm should increase to 850 rpm. If it does not, repeat steps 5 through 7.

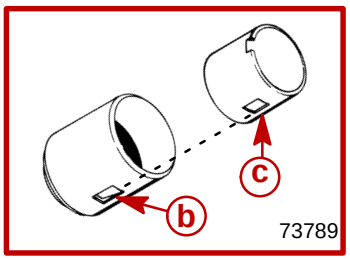


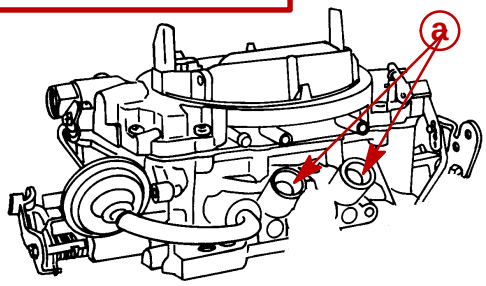
73662

10. If after performing the above procedure several times, the correct results can still not be obtained, check the following:

- PVS not working properly.
- Incorrect float level.
- Vacuum leaks.

11. Once the idle speed and mixture adjustment is correct, install the seal plugs over mixture screws. Ensure the opening in plug snaps into the tab in the cup.





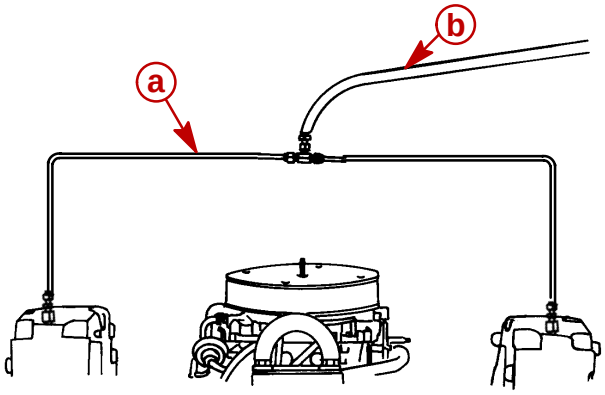
a - Screw Seal
b - Tab In Cup
c - Opening In Cup

12. Reinstall the flame arrestor.

Test Equipment

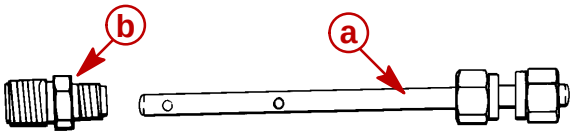
The following equipment, provided by the Dealer or Inspector, is needed to perform an emissions test on this engine:

- Test Probes.
- Test Probe Collector.
- Exhaust System Analyzer.



a - Exhaust Probe Collector
b - To Exhaust Analyzer

Emissions Testing



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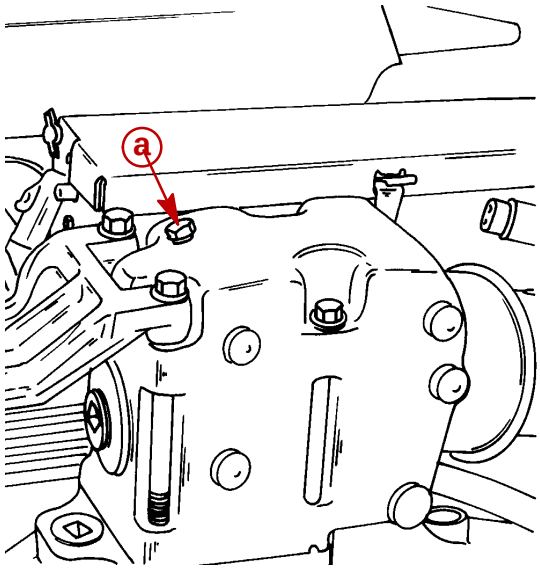
a - Exhaust Test Probes (2)
b - Exhaust Elbow Adapter Fittings (2)

1. Remove plugs from both exhaust elbows.



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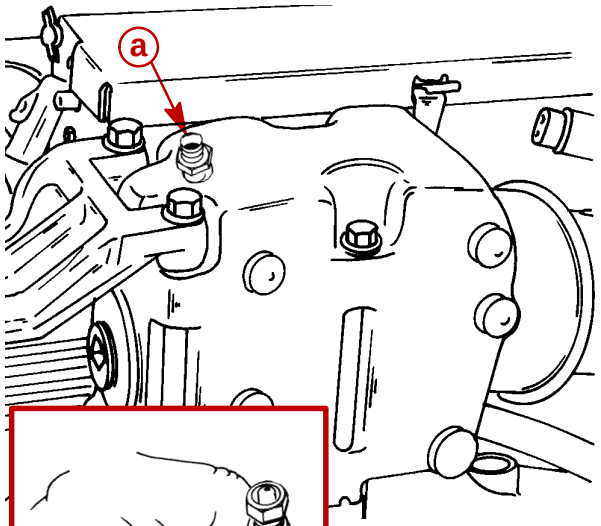
Typical

a - Plugs (Port And Starboard Elbows)

2. Install exhaust elbow adapter fittings into elbows. Apply Loctite Pipe Sealant with Teflon to threads that go into elbow. Tighten securely.

3. Insert exhaust test probes into fittings and tighten securely.



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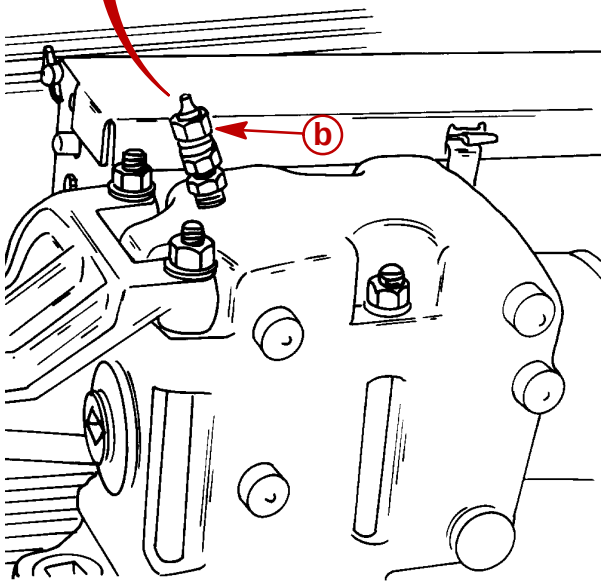

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a - Adapter Fittings
b - Exhaust Test Probes

4. When exhaust emissions test is complete, remove test probes and adapter fittings and reinstall the plugs. Apply Perfect Seal to threads before installing. Torque to 150 lb-in. (17 Nm).

NOTICE to INSTALLER

Your engine is equipped with special design features and special tuning to minimize emission output from the engine. You should follow:

- **Recommended maintenance schedules particularly the ignition system**
- Proper engine tuning procedures to ensure these features remain in good operating order.
- Proper steps to maintain the engine within specification.

The instructions in the Emissions Kit provide the necessary information to properly convert the engine to meet the applicable SAV1 Regulations. There is another item within the regulation that is beyond the control of Mercury Marine. This item is related to the fuel filling system on the boat. The requirements for the fuel filler neck are as follows:

- Must be designed so that it is impossible to use a fuel nozzle with an outside diameter of more than 23.6 mm.
- The filler neck shall be durable and designed so that modifications are not possible.
- A durable, legible plate shall be mounted on the boat near the fuel filler neck. This plate shall read “UNLEADED GASOLINE ONLY.”

Any questions about the fuel filler neck requirement and availability would be directed to the boat manufacturer.

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FUEL SYSTEM

Section 5E - Fuel Delivery System For Electronic Fuel Injection

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Torque Specifications	5E-2	Water Separating Fuel Filter Replacement	5E-8
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Replacement Parts Warning	5E-2	Disassembly	5E-10
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Fuel Supply Connections	5E-3	Installation	5E-13
Fuel Delivery System	5E-4	Vacuum and Vent Hose Routing	5E-15
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5 E

Specifications

Description	Specification
Pump Pressure	30 PSI (207 kPa)

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Fuel Lines		18	24
Fuel Fittings		See Note	

Tools

Description	Part Number
Fuel Pressure Gauge	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
#592 Loctite Pipe Sealant with Teflon	Obtain Locally

NOTE: *Refer To “Fuel Supply Connections” Warning following.*

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark and/or open flames in the area. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure that no fuel leaks exist before closing engine hatch.

⚠ WARNING

Avoid Fire or Explosion: Fuel injection system is pressurized during operation. Use care when removing water separating fuel filter. Fuel could spray on hot engine causing fire or explosion. Allow engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it to help avoid fuel spraying on the engine.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

Fuel Delivery System

Recommendations

⚠ WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing fuel delivery system.

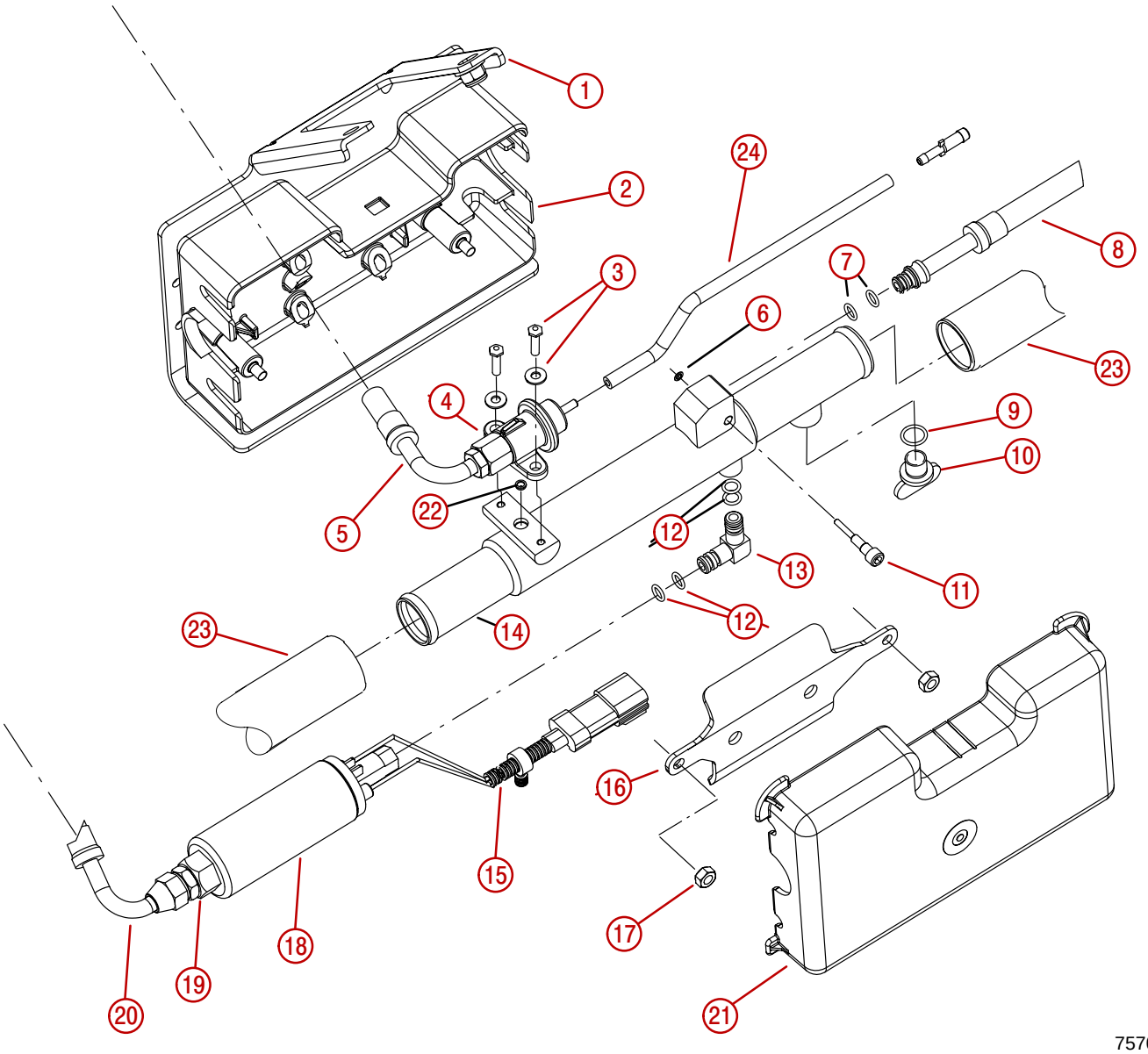
The Fuel Tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank or boat manufacturer.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered. Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines.

1. Fuel pickup should be at least 1 in. (25mm) from the bottom of fuel tank to prevent picking up impurities.
2. Fuel lines used must be Coast Guard approved (USCG Type A1).
3. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must not be smaller than 1/2 in. (13mm) I.D.
4. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
5. Fuel line(s) should be installed free of stress and firmly secured to prevent vibration and/or chafing.
6. Sharp bends in fuel lines should be avoided.
7. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Cool Fuel System Exploded View



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Exploded View Component List

1 - Bracket
2 - Cover Base
3 - Screw and Washer (2)
4 - Fuel Pressure Regulator
5 - Return Fuel Line
6 - Retaining Ring
7 - O-Rings (2)
8 - Fuel Line To Throttle Body
9 - Gasket
10 - Drain Plug
11 - Stepped Screw
12 - O-Rings (4)
13 - Elbow
14 - Fuel Cooler
15 - Fuel Pump Wiring Harness
16 - Retainer Bracket
17 - Nut (2)
18 - Electric Fuel Pump
19 - Inlet Fitting
20 - Fuel Line Inlet
21 - Cover
22 - Filter
23 - Seawater Hoses (Hose Clamps Not Shown)
24 - Vacuum Hose

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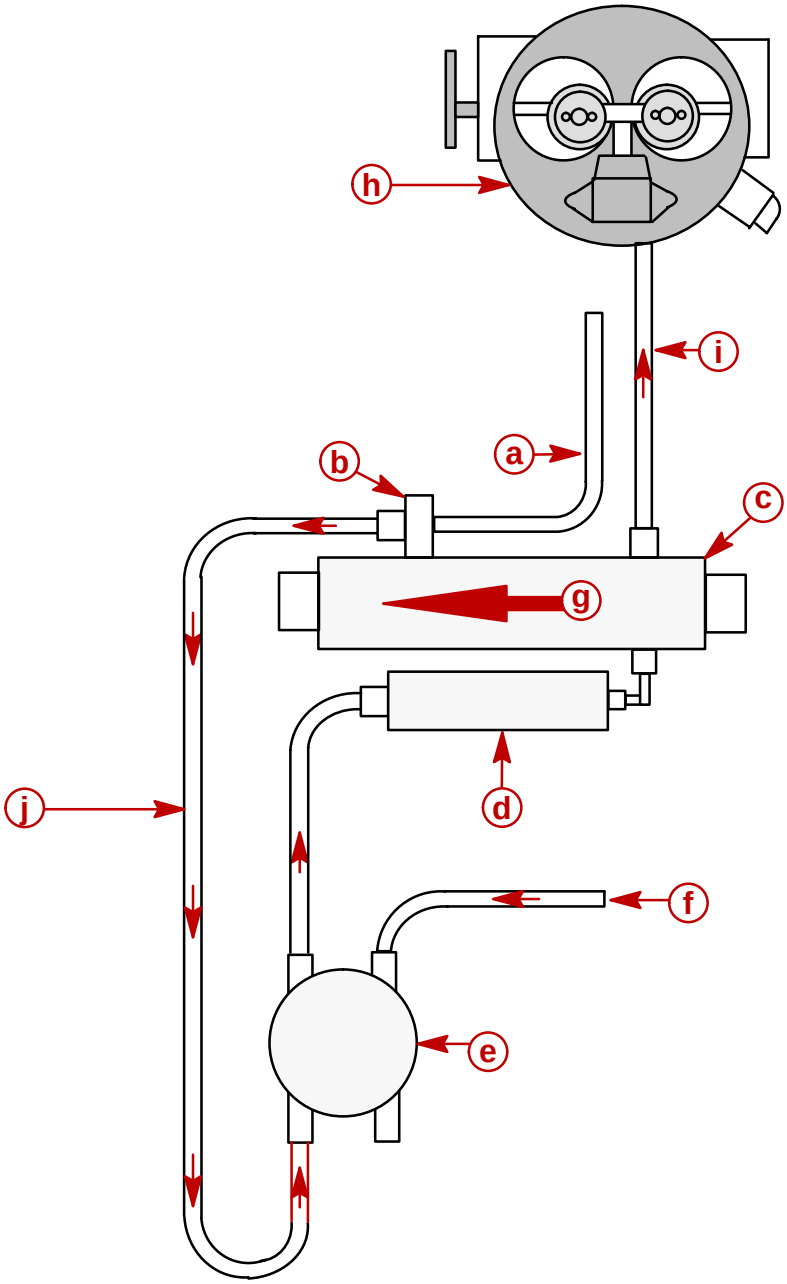
Fuel System Flow Diagrams

Throttle Body Injection



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All Throttle Body Fuel Injection Is Similar

- **a** - Diaphragm Rupture Line To Flame Arrestor
- **b** - Fuel Pressure Regulator
- **c** - Fuel Cooler
- **d** - Electric Fuel Pump
- **e** - Water Separating Fuel Filter
- **f** - Fuel From Tank
- **g** - Direction Of Water Flow
- **h** - Throttle Body Unit
- **i** - Fuel Line To Throttle Body
- **j** - Excess Fuel Return To Water Separating Fuel Filter

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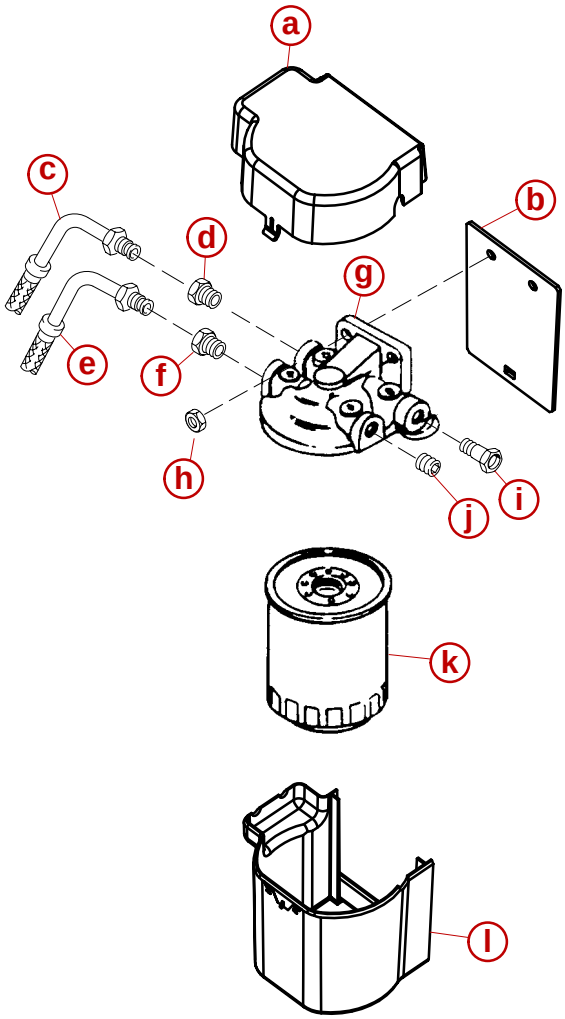
Water Separating Fuel Filter

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.



a - Top Cover (If Equipped)
b - Insulator Plate
c - Fuel Return Line from Regulator
d - Brass Fitting
e - Fuel Line to Fuel Pump
f - Brass Fitting
g - Fuel Filter Mounting Bracket
h - Nut
i - Fuel Inlet Fitting
j - Plug
k - Water Separating Fuel Filter
l - Bottom Cover (If Equipped)

Water Separating Fuel Filter Replacement

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel filter from base. A filter wrench may be needed.
3. Lubricate sealing ring(s) of new filter with engine oil.
4. Install new filter. Tighten securely by hand.
5. Reconnect battery cables.
6. Supply water to cooling system.
7. Start engine.
8. Check for fuel leaks.

Cool Fuel System Repair

Removal

1. Disconnect battery cables from battery.

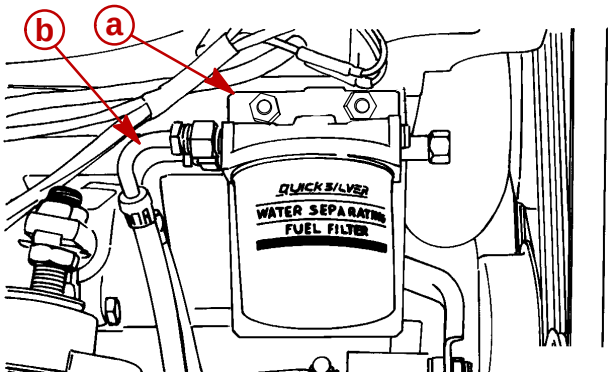
IMPORTANT: Suitably plug open ends of fuel line connections to prevent fuel leaks and entry of water or contaminates into lines while working.

2. Close fuel shutoff valve, if equipped and remove the fuel tank inlet line from the water separating fuel filter. If boat is not equipped with a fuel tank shut off valve, remove the fuel tank inlet line at the water separating fuel filter and plug the line.

⚠ CAUTION
If boat is to remain in the water, the seacock, if equipped, must remain closed until engine is to be restarted to prevent water from flowing back into seawater cooling system. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine

3. Close seacock, if equipped. If boat is not equipped with a seacock, remove and plug the seawater inlet hose.
4. Drain seawater system. Refer to SECTION 1B.
5. Disconnect seawater hoses from fuel cooler.

6. Disconnect fuel lines from water separating fuel filter adapter.



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a - Filter Adapter
b - Fuel Lines

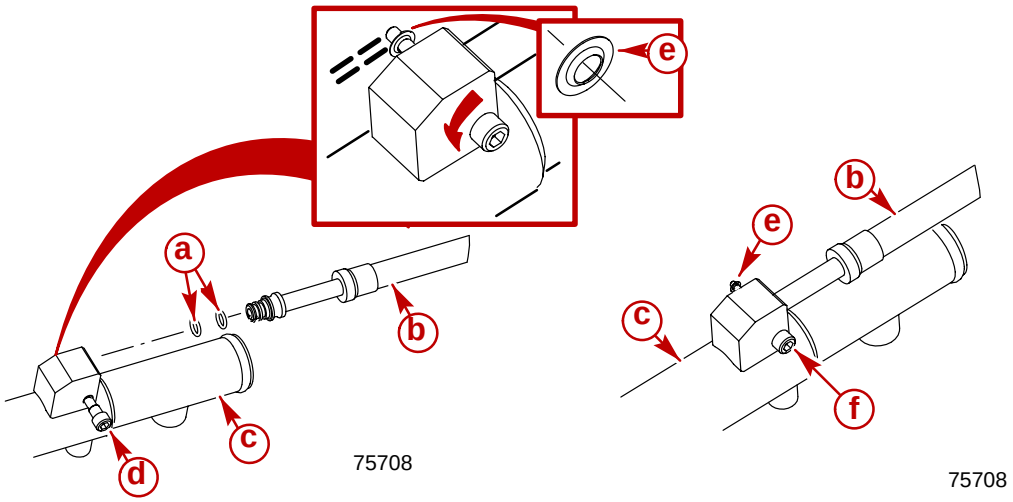
7. Disconnect the fuel line from the throttle body.
8. Remove the cover from the cool fuel system.
9. Disconnect the fuel pump electrical connector.
10. Disconnect the vacuum hose connected to the pressure regulator.
11. Remove the two upper engine mount bracket nuts retaining fuel cooler bracket to the engine.
12. Carefully remove the cool fuel system assembly.

Disassembly

NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

1. Remove the two nuts from the Cool Fuel retaining bracket studs. Lift the retainer bracket and cooler/pump assembly from the cover base.

IMPORTANT: To prevent loss of the stepped screw used to secure the cooler-to-throttle body fuel line, a retainer ring is provided. Do not remove the retainer or stepped screw.

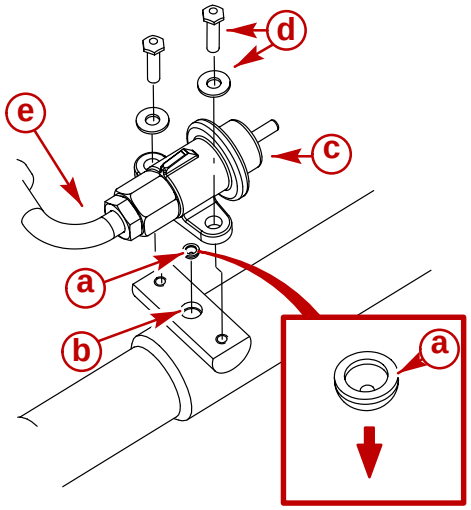


a - Fuel Line O-Rings
b - Fuel Line, Cooler-to-Throttle Body
c - Fuel Cooler
d - Stepped Screw - Loosened To Accept Fuel Line
e - Retainer Ring
f - Stepped Screw - Torqued

2. Disconnect the fuel lines from the assembly.
3. Disconnect the elbow fitting and fuel pump from the cooler assembly.
4. Remove the elbow fitting from the fuel pump (to allow replacement of O-rings during assembly).
5. Remove the two screws retaining the fuel pressure regulator to the fuel cooler.
6. Remove the regulator.
7. Remove and retain the seawater drain plug and seal from the cooler.

Reassembly

1. Install the small filter (conical side DOWN) in the orifice of the new fuel cooler where the fuel pressure regulator mounts.
2. Install the regulator onto the cooler using the two screws with washers. Torque the screws to 53 lb-in. (5.8 Nm).
3. Using wrench to stabilize the fitting, connect the fuel line to the regulator. Tighten securely.



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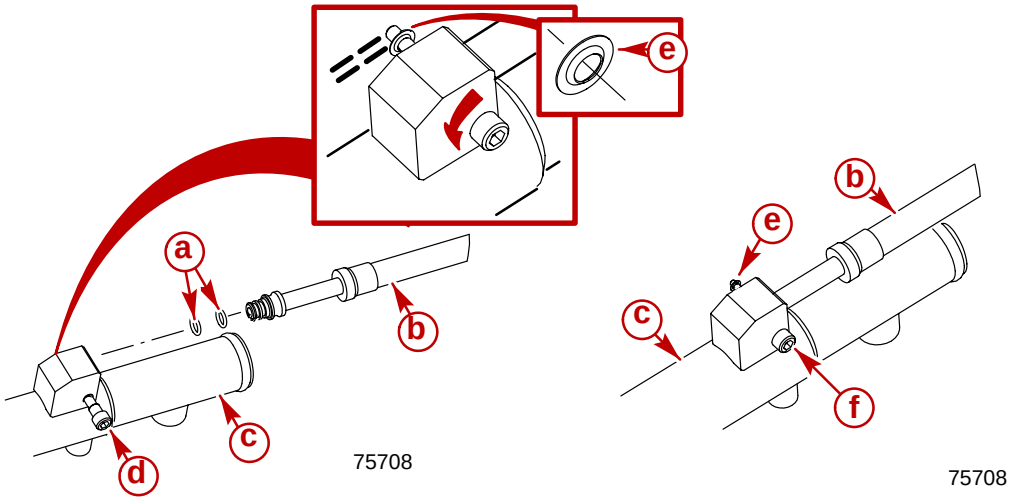
a - Filter
b - Fuel Cooler Orifice
c - Pressure Regulator
d - Screw and Washer
e - Fuel Line

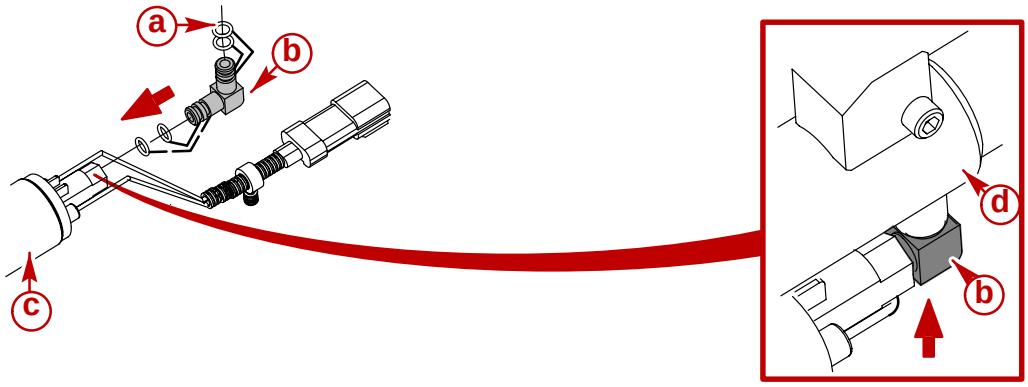
4. Install the throttle body fuel line as follows:
   a. Install two (of six) O-rings onto the cooler-to-throttle body fuel line where it attaches to the cooler, if not already present.
   b. Completely loosen, but do NOT remove, the stepped screw that retains the fuel line.
   c. Lubricate the two fuel line O-rings with a small amount of liquid dish soap (obtain locally).
   d. Insert the fuel line into the cooler orifice. Hand tighten the special screw.
   e. Torque the stepped screw to 81 lb-in. (9 Nm).

IMPORTANT: To prevent loss of the stepped screw used to secure the cooler-to-throttle body fuel line, a retainer ring is provided. Do not remove the retainer or stepped screw.



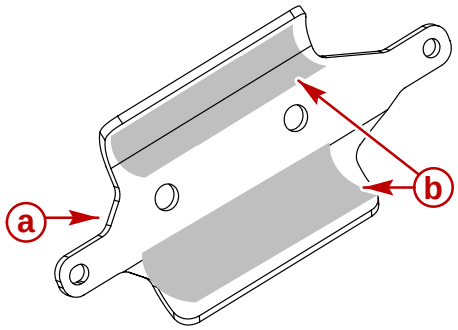
a - Fuel Line O-Rings
b - Fuel Line, Cooler-to-Throttle Body
c - Fuel Cooler
d - Stepped Screw - Loosened To Accept Fuel Line
e - Retainer Ring
f - Stepped Screw - Torqued
g - Retainer Ring

5. Install the fuel pump to the cooler as follows:
   a. Install the remaining four (of six) O-rings on the fuel pump / cooler elbow fitting as shown.
   b. Lubricate O-rings for the elbow fitting with a small amount of liquid dish soap (obtain locally).
   c. Install the elbow in the fuel pump.
   d. Install the fuel pump with elbow fitting in the cooler assembly.



a - O-Rings (4)
b - Elbow Fitting
c - Fuel Pump
d - Fuel Cooler

6. Position the completed fuel cooler assembly in the cover base.
7. Apply a thin, even coating of Thermal Grease on all of the retainer bracket inside surfaces where it contacts the cooler and the fuel pump when installed.

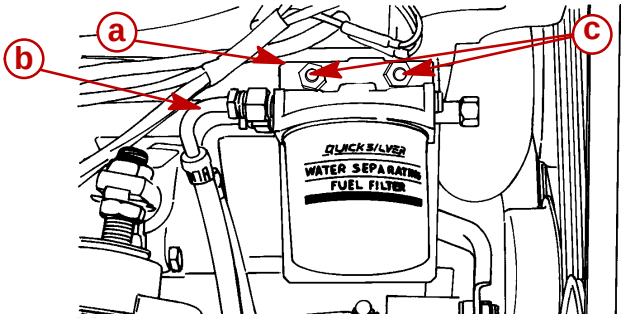


a - Retainer Bracket
b - Thermal Grease

8. Install the retainer bracket over the cooler and fuel pump. Apply Loctite 242 to the threads of the mounting studs. Torque the two nuts to 50 lb-in. (5.6 Nm).
9. Install and securely tighten the seawater drain plug.

Installation

1. If removed, reinstall the fuel filter assembly and secure using the two self locking nuts. Tighten securely.
2. Using wrench to stabilize brass filter nut, connect the fuel lines to the fuel filter adapter. Tighten securely.



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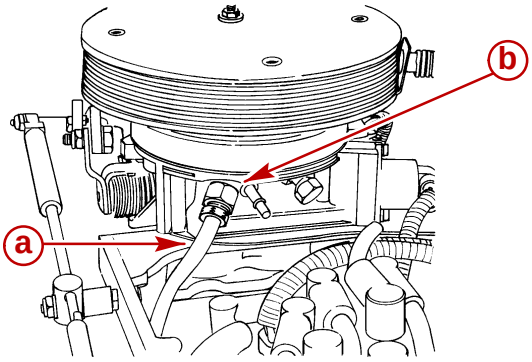
a - Filter Assembly
b - Fuel Lines
c - Lock Nuts

3. Route the fuel lines as needed and place the Cool Fuel assembly on the engine mount studs. Install the two engine mounting nuts. Torque to 30 lb-ft (41 Nm).
4. Install the cooler-to-throttle body fuel line as follows:
   a. Route the fuel line to the back side of engine.

b. Using wrench to stabilize brass filter nut, connect the fuel line to the throttle body fitting at location shown. Tighten securely.



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a - Fuel Line, Fuel Cooler-to-Throttle Body
b - Fuel Fitting

5. Install distributor cap (if removed).
6. Connect vacuum line to fuel pressure regulator.
7. Attach engine harness electrical connector to fuel pump harness connector.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

8. Connect seawater hoses to Cool Fuel system. Tighten hose clamps securely.
9. Unplug and connect seawater inlet hose. Open seacock, if equipped.
10. Unplug and connect fuel tank supply inlet hose. Tighten hose clamp securely. Open fuel shutoff valve, if equipped.

⚠ CAUTION

When installing battery, be sure to connect POSITIVE (+) battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, electrical system damage will result.

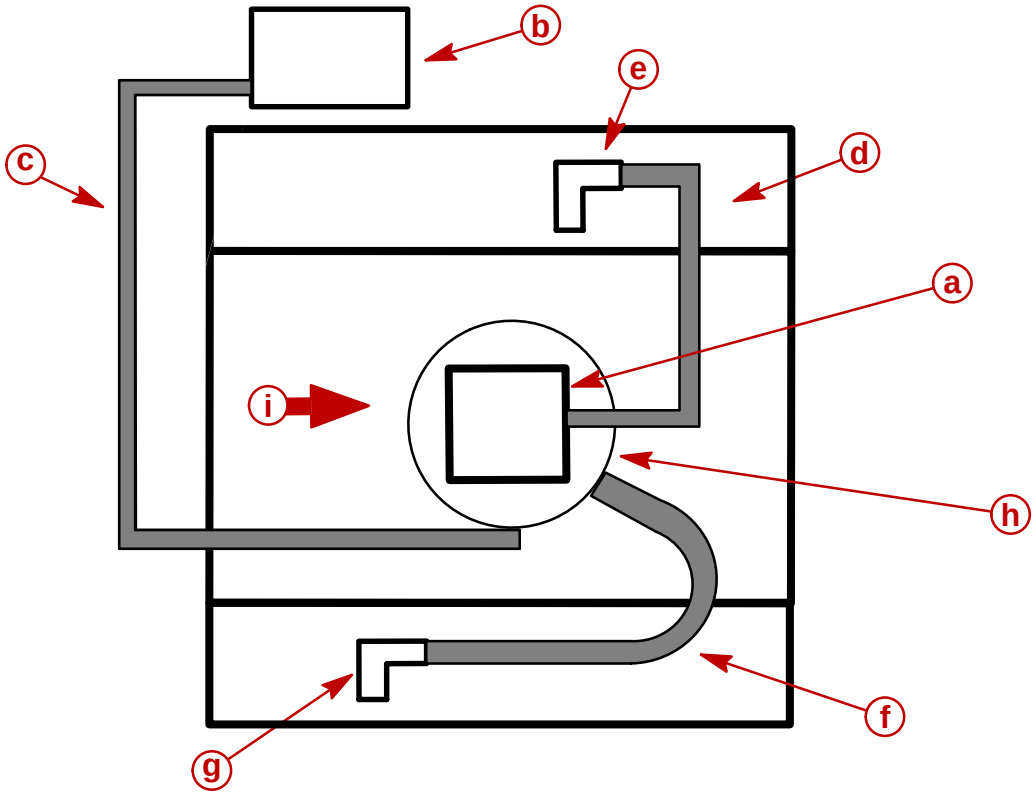
11. Clean battery cable clamps and terminals and reconnect cables (see **CAUTION** listed above). Secure each cable clamp when connecting. Coat terminals with a battery terminal anti-corrosion spray to help retard corrosion.
12. Start the engine and check for fuel and water leaks. Stop the engine immediately if any leaks exist. Make necessary corrections.
13. Install cool fuel system cover.

⚠ WARNING

Make sure no leaks exist before closing engine hatch.

Vacuum and Vent Hose Routing

Throttle Body EFI



a - Throttle Body
b - Cool Fuel Assembly
c - Diaphragm Rupture Hose - Fuel Pressure Regulator on Cool Fuel Assembly To Side of Flame Arrestor
d - Vent Hose - PCV Valve to Flame Arrestor
e - PCV Valve
f - Vent Hose - Valve Cover Fitting To Throttle Body
g - Valve Cover Fitting
h - Flame Arrestor
i - Front of Engine

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FUEL SYSTEMS

Section 5F - Fuel Injection Descriptions And System Operation

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Special Tools

Part Number	Tool Name	Description
J-34029-A (***Note 1*** and ***2***)	High Impedance Multimeter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ.
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator.
J-34142-B (***Note 3***)	Unpowered Test Light	Used to check circuit wiring, short to ground or voltage.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
94050m	MerCruiser Scan Tool Version 3.4 (English)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors. Tool can read MEFI 1 and MEFI 3 ECM.
94008	Code Mate Tester	Flashes light to display problem codes.
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A5	Fuel Pressure Gauge Kit	Used to check fuel system pressure. Kit includes 91-803135 Test Port Adaptor Kit and 91-806901 TBI Pressure Valve.
91-823686A2	Quicksilver Digital Diagnostic Terminal (DDT)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-803999	MerCruiser DDT Cartridge Version 2	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Tool can read MEFI 1 and MEFI 3 ECM.
84-822560A2	DDT Adaptor Harness	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-805747A2	EFI Timing Tool	Used to set Ignition timing. Plug connects to DLC.
91-805918A2	Fuel Shutoff Tool	Used to perform fuel system pressure test.
91-806901	Fuel Line Connector	Allows connection of Fuel Pressure Gauge.

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Special Tools (continued)

NOTE: *[1] The High Impedance Multimeter that comes with the existing Outboard 2 Cycle EFI Tester, P/N 91-11001A2 meets the requirements listed above.*

NOTE: *[2] Quicksilver Digital Tachometer / Multi-Meter (DMT 2000) P/N 91-854009A1, meets the requirements listed above.*

NOTE: *[3] Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

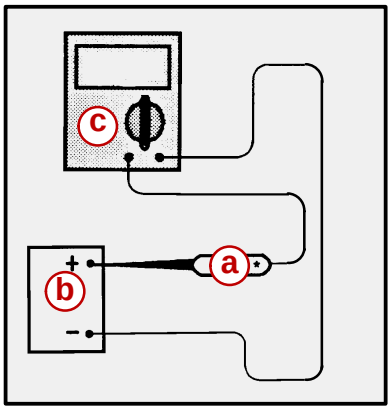
Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 773-736-6633
Fax: 773-736-2950
E-mail: rinda@mcs.net

Service Precautions

The following requirements must be observed:

- Before removing any ECM system component, disconnect the negative battery cable.
- Never start the engine without the battery being solidly connected.
- Never separate the battery from the on-board electrical system while the engine is running.
- Never separate the battery feed wire from the charging system while the engine is running.
- When charging the battery, disconnect it from the boat's electrical system.
- Ensure that all cable harnesses are connected solidly and that battery connections are thoroughly clean.
- Never connect or disconnect the wiring harness at the ECM when the ignition is switched ON.
- Before attempting any electric arc welding, disconnect the battery leads and the ECM connector(s).
- When steam cleaning engines, do not direct the steam cleaning nozzle at ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
- Use only the test equipment specified in the diagnostic charts, since other test equipment may either give incorrect results or damage good components.
- All voltage measurements using a voltmeter require a digital voltmeter with a rating of 10 megohms input impedance.

- When a test light is specified, a “low-power” test light must be used. DO NOT use a high-wattage test light. While a particular brand of test light is not suggested, a simple test, as shown below, on any test light will ensure it to be safe for system circuit testing. Connect an accurate ammeter (such as the high impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vehicle battery.



a - Test Light
b - Battery
c - Ammeter

IMPORTANT: If the ammeter indicates LESS than 3/10 amp. current flow (.3 A or 300 mA), the test light is SAFE to use.

If the ammeter indicates MORE than 3/10 amp. current flow (.3 A or 300 mA), the test light is NOT SAFE to use.

NOTE: *Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

- *When using a DVOM to perform voltage measurements, turn the ignition OFF when connecting the DVOM to the circuitry to be tested.*

⚠ CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed: proper service and repair are important to the safety of the service technician and the safe, reliable operation of all MerCruiser Electronic Fuel Injection equipped engines. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality. The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specially designed for the purpose. Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by the system manufacturer, must first determine that neither his safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure or tool selected. It is important to note that this manual contains various “Cautions” and “Notes” that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the engine or render it unsafe. It is also important to understand that these “Cautions” and “Notes” are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

General Information

Introduction

The following manual has been prepared for effective diagnosis of the MerCruiser Electronic Fuel Injection system.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

An understanding of the material contained herein and in subsequent publications issued when necessary, will assist service personnel in properly maintaining the quality to which MerCruiser engine control systems are built.

Visual/Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further steps. Inspect all vacuum hoses for correct routing, pinches, cuts, or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

Basic Knowledge and Tools Required

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. You should be familiar with wiring diagrams; the meaning of volts, ohms and amperes; the basic theories of electricity; and understand what happens in an open or shorted wire. To perform system diagnosis, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools which are required for system service are listed later in this section (see “Table of Contents”).

Electrostatic Discharge Damage

Electronic components are often designed to carry very low voltage and are susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes 4,000 volts for a person to even feel the effect of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage. Use care when handling and testing electronic components.

Diagnostic Information

The diagnostic charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. **The charts are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.**

Wiring Harness Service

Marine engine control circuits contain many special design features not found in standard land vehicle wiring. Environmental protection is used extensively to protect electrical contacts and proper splicing methods must be used.

The proper operation of low amperage input/output circuits depends upon good continuity between circuit connectors. Before component replacement and/or during normal troubleshooting procedures, visually inspect any questionable mating connector. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below.

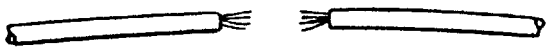
1. Improperly formed contacts and/or connector housing.
2. Damaged contacts or housing due to improper engagement.
3. Corrosion, sealer or other contaminants on the contact mating surfaces.
4. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
5. Tendency for connectors to come apart due to vibration and/or temperature cycling.
6. Terminals not fully seated in the connector body.
7. Inadequate terminal crimps to the wire.

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices, as shown in the following illustrations. Use care when probing a connector or replacing connector terminals. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers. Microscopic damage or holes will result in eventual water intrusion, corrosion and/or component or circuit failure.

WIRE REPAIR

1. Locate damaged wire.
2. Remove insulation as required.



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3. Splice two wires together using splice clips and rosin core solder.

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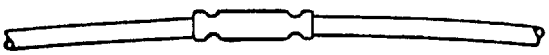
4. Cover splice with heat shrink sleeve to insulate from other wires.



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Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt that could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the Parts Catalog.

Ensure that the connector seals are not deformed or crushed when mating the connectors together.

Abbreviations

in. hg	Inches Of Mercury	IGN	Ignition
BARO	Barometric Pressure	INJ	Injection
BAT	Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive	KS	Knock Sensor System
CKT	Circuit	KV	Kilovolts
CONN	Connector	MAP	Manifold Absolute Pressure
CYL	Cylinder	MIL	Malfunction Indicator Lamp
DEG	Degrees	mSec	Millisecond
DIAG	Diagnostic	N/C	Normally Closed
DIST	Distributor	N/O	Normally Open
DLC	Data Link Connector	PROM	Programmable Read Only Memory
DTC	Diagnostic Trouble Code	RAM	Random Access Memory
DVOM	Digital Volt Ohm Meter	REF HI	Reference High
ECM	Engine Control Module	REF LO	Reference Low
ECT	Engine Coolant Temperature	ROM	Read Only Memory
EEPROM	Electronic Erasable Programmable Read Only Memory	SLV	Slave
HEI	High Energy Ignition	SW	Switch
EMI	Electromagnetic Interference	TACH	Tachometer
ENG	Engine	TERM	Terminal
GND	Ground	TP	Throttle Position
GPH	Gallons Per Hour	V	Volts
IAC	Idle Air Control	VAC	Vacuum
IAT	Intake Air Temperature	WOT	Wide Open Throttle
IC	Ignition Control		

ECM Self-Diagnostics

The ECM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of diagnostic codes. The codes are two digit numbers that can range from 12 to 51. When a malfunction is detected by the ECM, a code is set and the Malfunction Indicator Lamp is illuminated.

Diagnostic Code Tool With Malfunction Indicator Lamp

There are various manufacturers of Diagnostic Code Tools. Most Tools are equipped with a Malfunction Indicator Lamp (MIL).

- It informs the service technician that a problem has occurred and that the vessel is in need of service as soon as reasonably possible.
- It displays Codes stored by the ECM which help the technician diagnose system problems.

As a bulb and system check, the lamp will come ON with the key on and the engine not running. When the engine is started, the light will turn OFF. If the lamp remains ON, the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after ten seconds, but a code will remain stored in the ECM.

When the lamp remains ON while the engine is running, or when a malfunction is suspected due to a driveability problem, "EFI Diagnostic Circuit Check" must be performed. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

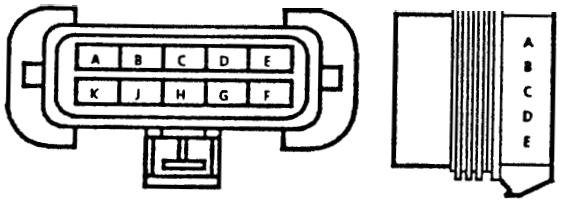
Intermittent Malfunction Indicator Lamp

In the case of an intermittent problem, the Malfunction Indicator Lamp will light for ten seconds and then will go out. However, the corresponding code will be stored in the memory of the ECM. When unexpected codes appear during the code reading process, one can assume that these codes were set by an intermittent malfunction and could be helpful in diagnosing the system.

An intermittent code may or may not reset. IF IT IS AN INTERMITTENT FAILURE, A DIAGNOSTIC CODE CHART IS NOT USED. Consult the "Diagnostic Aids" on the same page as the diagnostic code chart. "Troubleshooting" also covers the topic of "Intermittents." A physical inspection of the applicable sub-system most often will resolve the problem.

Reading Codes

The provision for communicating with the ECM is the Data Link Connector (DLC) connector. It is part of the EFI engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The code(s) stored in the ECM's memory can be read either through a scan tool, (a diagnostic scanner that plugs into the DLC connector), or by counting the number of flashes of the Malfunction Indicator Lamp when the diagnostic code tool is installed and SERVICE mode is selected.



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DLC Connector

Once the diagnostic code tool has been connected, the ignition switch must be moved to the ON position, with the engine not running. At this point, the Malfunction Indicator Lamp should flash Code 12 three times consecutively. This would be the following flash sequence: flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash. Code 12 indicates that the ECM's diagnostic system is operating. If Code 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart in "Diagnostics."

Following the output of Code 12, the Malfunction Indicator Lamp will indicate a diagnostic code three times if a code is present, or it will simply continue to output Code 12. If more than one diagnostic code has been stored in the ECM's memory, the codes will be output from the lowest to the highest, with each code being displayed three times.

If a scan tool is used to read the codes, follow the manufacturer's instructions.

SERVICE MODE

When the diagnostic code tool is installed at the Data Link Connector (DLC) and the selector switch is set at SERVICE, the system will enter what is called the SERVICE mode. In this mode the ECM will:

1. Display a Code 12 by flashing the Malfunction Indicator Lamp (indicating the system is operating correctly).
2. Display any stored codes by flashing the Malfunction Indicator Lamp. Each code will be flashed three times, then Code 12 will be flashed again.
3. Holds ignition advance steady.

NORMAL MODE

Engines can be monitored in the normal mode. Certain parameters can be observed without changing the engine operating characteristics.

Scan Tools

The ECM can communicate a variety of information through the DLC connector. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the tool displays, and knowledge of the circuits involved, the tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

Scan tools do not make the use of diagnostic charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. Diagnostic tables incorporate diagnosis procedures using a scan tool where possible or a Diagnostic Code Tool (non-scan) if a scan tool is unavailable.

EFI Diagnostic Circuit Check

After the visual/physical inspection, the On Board Diagnostic (OBD) Circuit Check is the starting point for all diagnostic procedures. Refer to SECTION 5I.

The correct procedure to diagnose a problem is to follow two basic steps.

1. Are the on-board diagnostics working? This is determined by performing the On Board Diagnostic Circuit Check. Since this is the starting point for the diagnostic procedures, always begin here. If the on-board diagnostics are not working, the EFI Diagnostic Circuit Check will lead to a diagnostic chart in “Diagnostics” to correct the problem. If the on-board diagnostics are working correctly, go to step 2.
2. If a code is stored, go directly to the numbered code chart in SECTION 5I. This will determine if the fault is still present.

Scan Tool Use With Intermittents

The scan tool allows manipulation of wiring harnesses or components with the engine not running, while observing the scan tool readout.

The scan tool can be plugged in and observed while running the vessel under the condition when the Malfunction Indicator Lamp turns ON momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while running the vessel. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a trouble code. Comparing the senor’s readings with those of the typical scan tool data readings may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technician’s ability to understand the system he is trying to diagnose as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer’s operating manual to become familiar with the tool’s operation.

Non-Scan Diagnosis of Driveability Concerns (With No Codes Set)

If a driveability concern still exists after following the diagnostic circuit check and reviewing "Troubleshooting," an out-of-range sensor may be suspected. Because of the unique design of the EFI system, fail-safes have been incorporated into the ECM to replace a sensed value with a default value in the case of a sensor malfunction or sensor wiring concern. By allowing this to occur, limited engine performance is restored until the vessel is repaired. A basic understanding of sensor operation is necessary in order to diagnose an out-of-range sensor.

If the sensor is within its working or acceptable parameters, as shown, the ECM does not detect a problem. If the sensor should happen to fall out of this "window," a code will be stored. A known default value will replace the sensed value to restore engine performance.

If the sensor is out of range, but still within the operating window of the ECM, the problem will go undetected by the ECM and may result in trouble later.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 20° F, but actual coolant temperature was 175° F. This would cause the ECM to deliver more fuel than was actually needed and result in an overly rich, rough running condition. This condition would not have caused a code to set as the ECM interprets this as within its range.

To identify a sensor which is out of range, unplug it while running the engine. After approximately two minutes, the diagnostic code for that sensor will set, a code, and replace the sensed value with a default value. If at that point a noticeable performance increase is observed, the non-scan code chart for that particular sensor should be followed to correct the problem.

NOTE: *Be sure to clear each code after disconnecting and reconnecting each sensor. Failure to do so may result in a misdiagnosis of the problem.*

Electronic Control Module (ECM) and Sensors

General Description

The MerCruiser Electronic Fuel Injection system is equipped with a computer that provides the operator with state-of-the-art control of fuel and spark delivery. Computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure. Voltage does not flow in circuits. Instead, voltage causes current. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays and lights lamps.

Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to communicate with each other.

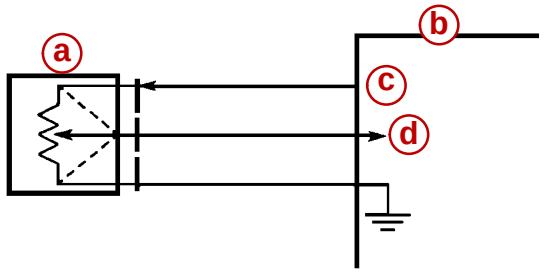
There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's important to understand the difference between them and the different ways they are used.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range. An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals: the 3-wire and the 2-wire sensor.

THREE-WIRE SENSORS (MAP AND TP)

The following figure shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground and a variable "wiper." The lead coming off of the wiper will be the signal to the Engine Control Module (ECM). As this wiper position changes, the signal voltage returned to the computer also changes.

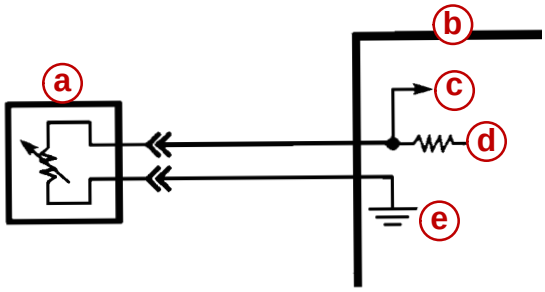


3-Wire Sensor

- **a** - Typical Sensor
- **b** - ECM
- **c** - Voltage Out
- **d** - Signal Input
- **e** - Sensor Ground

TWO-WIRE SENSOR (ECT)

The following figure is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies inversely with temperature.

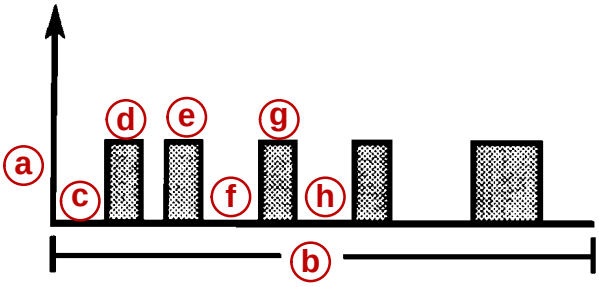


2-Wire Sensor

- **a** - Typical Sensor
- **b** - ECM
- **c** - Signal Sensor
- **d** - 5 Volt
- **e** - Sensor Ground

Digital Signals

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1 V, 2 V or 3 V would be allowed, but 1.27 V or 2.65 V would not. Digital signals are especially useful when the information can only refer to two conditions - YES and NO, ON and OFF, or HIGH and LOW. This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). As you can see in the following figure, a digital binary signal is a square wave.



Digital Binary Signal

- **a** - Voltage
- **b** - Time
- **c** - Lo
- **d** - Hi
- **e** - On
- **f** - Off
- **g** - Yes
- **h** - No

The computer uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each zero and each one is called a bit of information, or just a “bit.” Eight bits together are called a “word.” A word, therefore, contains some combination of eight binary code bits: eight ones, eight zeros, five ones and three zeros, and so on.

Binary code is used inside a computer and between a computer and any electronic device that understands the code. By stringing together thousands of bits, computers can communicate and store an infinite variety of information. To a computer that understands binary, 11001011 might mean that it should reset engine rpm at a lower level. Although the computer uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

SWITCH TYPES

Switched inputs (also known as discretes) to the computer can cause one bit to change, resulting in information being communicated to the computer. Switched inputs can come in two types: they are “pull-up” and “pull-down” types. Both types will be discussed.

With a pull-up type switch, the ECM will sense a voltage when the switch is CLOSED. With the pull-down switch, the ECM recognizes the voltage when the switch is OPEN.

Discretes can also be used to inform a computer of FREQUENCY information.

PULSE COUNTERS

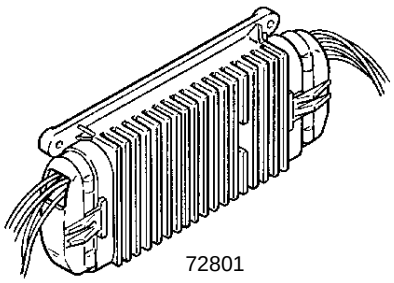
For the computer to determine frequency information from a switched input, the computer must measure the time between voltage pulses. As a number of pulses are recorded in a set amount of time, the computer can calculate the frequency. The meaning of the frequency number can have any number of meanings to the computer.

An example of a pulse counter type of input is the distributor reference pulse input. The computer can count a train of pulses, a given number of pulses per engine revolution, and determine the rpm of the engine.

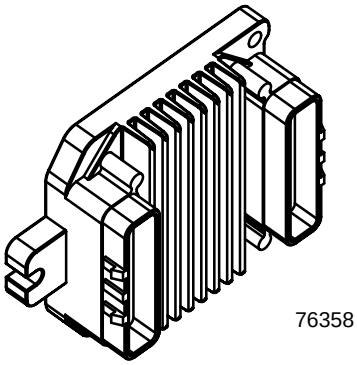
Engine Control Module (ECM)

The Engine Control Module (ECM) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect engine performance.

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a code or codes which identify the problem areas to aid the technician in making repairs.



MEFI-1 ECM



MEFI-3 ECM

ECM FUNCTION

The ECM supplies 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a **10 megohm input impedance digital voltmeter** is required to assure accurate voltage readings.

MEMORY

There are three types of memory storage within the ECM: ROM, RAM and EEPROM.

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control programs. Once the ROM is programmed, it cannot be changed. The ROM memory is non-erasable, and does not need power to be retained.

Random Access Memory (RAM) is the microprocessor “scratch pad.” The processor can write into, or read from, this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained.

Electronic Erasable Programmable Read Only Memory (EEPROM) is the portion of the ECM that contains the different engine calibration information that is specific to each marine application.

Speed Density System

The Electronic Fuel Injection system is a speed and air density system. The system is based on speed / density fuel management.

Three specific data sensors provide the ECM with the basic information for the fuel management portion of its operation. That is, three specific signals to the ECM establish the engine speed and air density factors.

SPEED

The engine speed signal comes from the distributor’s High Energy Ignition (HEI) module to the ECM on the distributor reference high circuit. The ECM uses this information to determine the speed or rpm factor for fuel and ignition management.

DENSITY

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loads. These pressure changes are supplied to the ECM in the form of electrical signals.

As intake manifold pressure increases (vacuum decreases), the air density in the intake manifold also increases, and additional fuel is required.

The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected by increasing the injector pulse width. As manifold pressure decreases (vacuum increases), the amount of fuel is decreased.

These two inputs from MAP and rpm are the major determinants of the air/fuel mixture, delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

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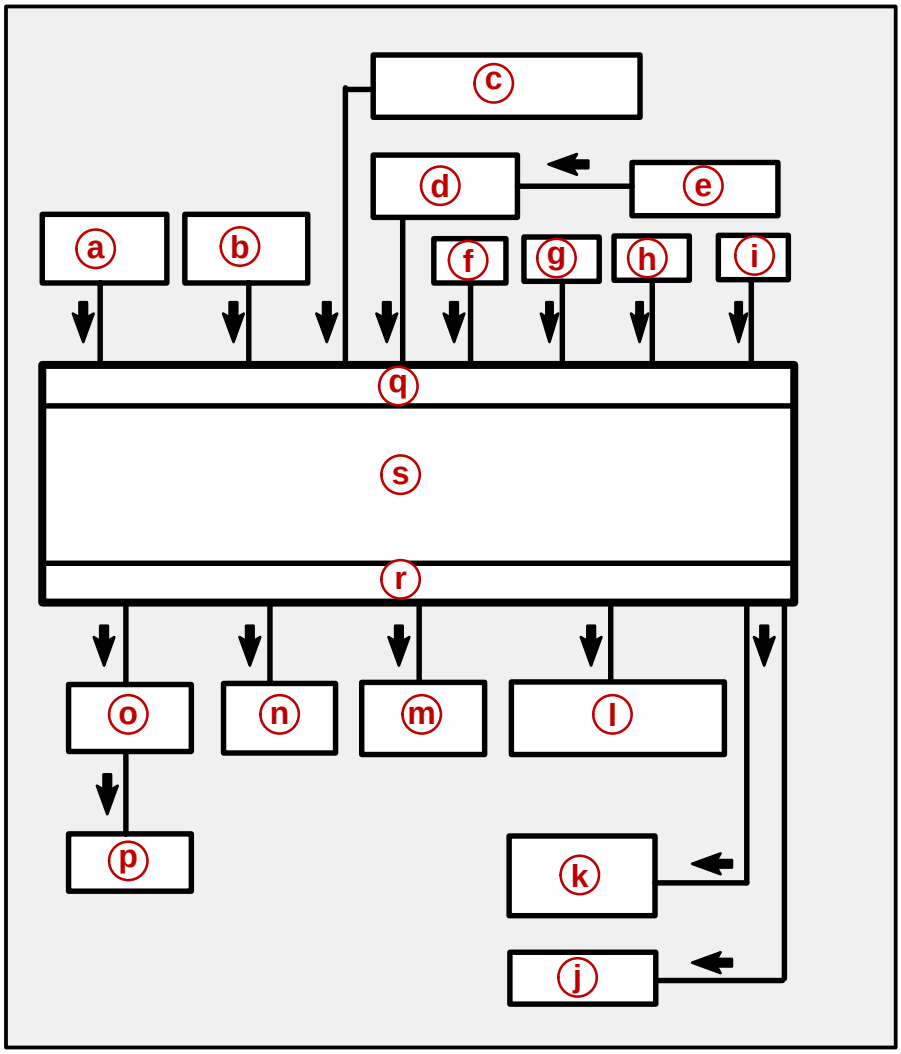
ECM Input and Sensor Descriptions

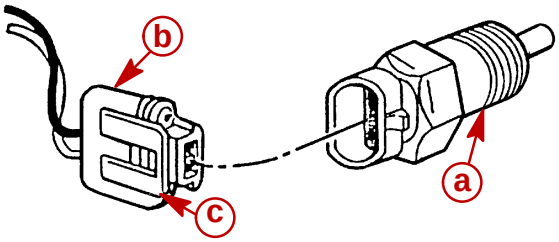
The following lists the sensors, switches and other inputs used by the ECM to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.



a - System Relay
b - Distributor For REF rpm
c - Discrete Switches (Audio Warning)
d - Knock Module
e - Knock Sensor
f - TP
g - MAP
h - ECT
i - IAT
j - Serial Data
k - Audio Warning Buzzer
l - Fuel Injectors
m - IAC Motor
n - Ignition Control Module
o - Fuel Pump Relay
p - Fuel Pump
q - Inputs
r - Outputs
s - ECM

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The Engine Coolant Temperature (ECT) Sensor is a thermistor (a resistor which changes value based on temperature) immersed in the engine coolant stream. Low coolant temperature produces a high resistance, while high temperature causes low resistance.



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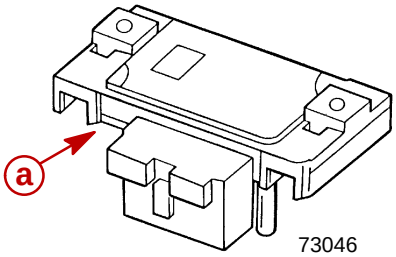
a - Engine Coolant Temperature (ECT) Sensor
b - Harness Connector
c - Locking Tab

The ECM supplies a 5 volt signal to the ECT through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the ECT circuit should set Code 14. Remember, this code indicates a failure in the coolant temperature sensor circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output.



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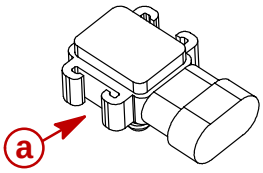

Earlier Style **Later Style**

a - Manifold Absolute Pressure (MAP) Sensor

A closed throttle on engine coast-down would produce a relatively low MAP output voltage, while a wide open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so 100% of outside air pressure is measured. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit should set a Code 33.

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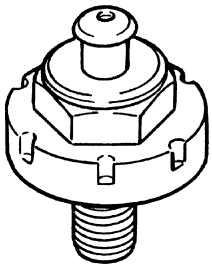
KNOCK SENSOR

On MEFI 1, the knock sensor is mounted on the lower right side of the engine block. MEFI 3 models do not have a knock sensor module mounted on the engine; it is located internal to the ECM.



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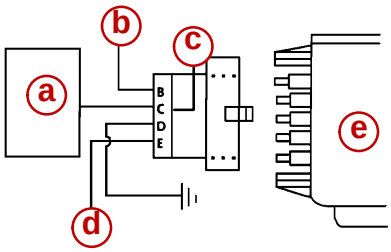
When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal which is sent to the KS Module and then to the ECM. The ECM uses this signal to aid in calculating ignition timing.

KNOCK SENSOR (KS) MODULE (MEFI 1 MODELS ONLY)

When the key switch is turned on, 12 volts are supplied to the KS module B terminal through the system relay. If this 12 volts are not present, the KS module cannot send the 8-10 volt signal to the ECM. This will cause a false constant ignition spark timing retard and a Code will be set.



Knock Sensor System

- **a** - Electronic Control Module (ECM)
- **b** - 12 Volts Battery Positive
- **c** - 8-12 Volts
- **d** - Knock Sensor
- **e** - Knock Sensor Module

The KS module monitors the knock sensor's AC voltage signal on terminal E. If no spark knock is present, an 8-10 volt signal is sent to the ECM by the KS module's terminal C. If spark knock is present, the module will remove this 8-10 volt signal to the ECM. The ECM will then retard the ignition spark timing to control the spark knock. If the circuit going to the module's E terminal opens or shorts to ground, the KS module cannot remove the 8-10 volt signal to the ECM and no spark retard will occur. The ground circuit for the KS module is connected to terminal D. If this circuit is open, the module cannot remove the 8-10 volt signal to the ECM either and spark knock cannot be controlled.

⚠ CAUTION

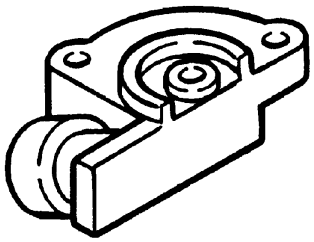
The correct Knock Sensor and KS module for an engine must be used or a spark knock may not be detected causing sever engine damage.

KNOCK SENSOR CIRCUITRY (MEFI-3 MODELS ONLY)

The MEFI-3 ECM is used with the knock sensor to control spark knock. The KS module circuitry is within the MEFI-3 ECM. When spark knock is present, a small AC voltage signal is sent from the knock sensor to the ECM through pin connector J1-30. (If the engine has a second KS, its voltage signal goes through pin connector J1-14). An AC voltage monitor inside the ECM will detect the spark knock and start retarding spark timing. A Code will be set only if the ECM does not see any activity on the KS signal circuit(s).

THROTTLE POSITION (TP) SENSOR

The Throttle Position (TP) Sensor is a potentiometer connected to the throttle shaft on the throttle body. The TP has one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TP. As the throttle valve angle is changed, the voltage output of the TP also changes. At a closed throttle position, the voltage output of the TP is low (approximately .5 volt). As the throttle valve opens, the output increases so that at wide-open-throttle (W.O.T.), the output voltage should be near 4.5 volts. By monitoring the output voltage from the TP, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TP can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving.



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If the TP circuit is open, the ECM will set a Code 21. If the TP circuit is shorted, and a trouble Code 21 will be set. A problem in any of the TP circuits will set a Code 21. Once a trouble code is set, the ECM will use a default value for TP.

DISTRIBUTOR REFERENCE (DIST REF)

The distributor reference (engine speed signal) is supplied to the ECM by way of the “Dist Ref Hi” line from the High Energy Ignition (HEI). This pulse counter type input creates the timing signal for the pulsing of the fuel injectors, as well as the Ignition Control (IC) functions. This signal is used for a number of control and testing functions within the ECM.

DISCRETE SWITCH INPUTS

Several discrete switch inputs are utilized by the system to identify abnormal conditions that may affect engine operation. These switches are used in conjunction with the ECM to detect critical conditions to engine operation.

The switches which are used with the fuel injection system to detect critical engine operation parameters are:

Switch	Normal State
Oil Pressure	N/O (With Pressure)
Gear Lube Monitor Level on Sterndrive	N/O (When Full)

Spark Management

High Energy Ignition with Ignition Control (IC)

The Electronic Fuel Injection is controlled by an Engine Control Module (ECM). This module is the nerve/decision center of the system. It uses all the information it gathers to manage ignition spark, delivering increased fuel economy and maximum engine performance.

The system uses inputs from sensors to make decisions on the amount of spark advance or retard allowed.

The system has been designed to control ignition advance and retard electronically by the ECM.

In order for the ECM to properly calculate spark advance, it must always know at what speed the engine is running. The engine speed signal is accomplished by a circuit within the distributor module which converts the pickup coil voltage to a square wave reference signal that can be used by the ECM. This square wave engine speed reference signal is known as REF HI. With MEFI 1, the ECM must also have something to compare the REF HI value against. Therefore, an additional line is provided between the ECM and the distributor module that is known as REF LO. These two lines, between the ECM and the distributor, provide a precise indication of engine speed.

With MEFI 1, the two other lines between the ECM and distributor that control the Ignition Control (IC) operation are known as the bypass and IC circuits.

Modes Of Operation

DISTRIBUTOR MODULE MODE (MEFI 1 ONLY)

The ignition system operates independent of the ECM. The distributor module module in the distributor maintains a base ignition timing and is able to advance timing to a total of 27 degrees. This mode is in control when a Code 42 is detected while engine is running and will have a noticeable effect on engine operation.

The following describes IC operation during cranking and when the engine starts running. To help understand how IC circuits operate, a relay with a double set of contact points is shown in the IC module (refer to the figures “Ignition Control Mode” and “ECM Control Mode”). Solid state circuitry is used in the module, but showing the relay makes it easier to visualize how the IC module functions.

During cranking, the relay is in the de-energized position (see figure “Distributor Module Mode”). This connects the pickup coil to the base of the transistor via the signal converter. When the pickup coil applies a positive voltage to the transistor, the transistor turns ON. When voltage is removed, the transistor turns OFF. When the transistor turns ON, current flows through the primary winding of the ignition coil. When it turns OFF, the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the IC module via a timing circuit, in case the engine remains in the ignition module timing mode.

With the relay de-energized, a set of contacts (shown closed) would ground the IC line signal.

ECM CONTROL MODE

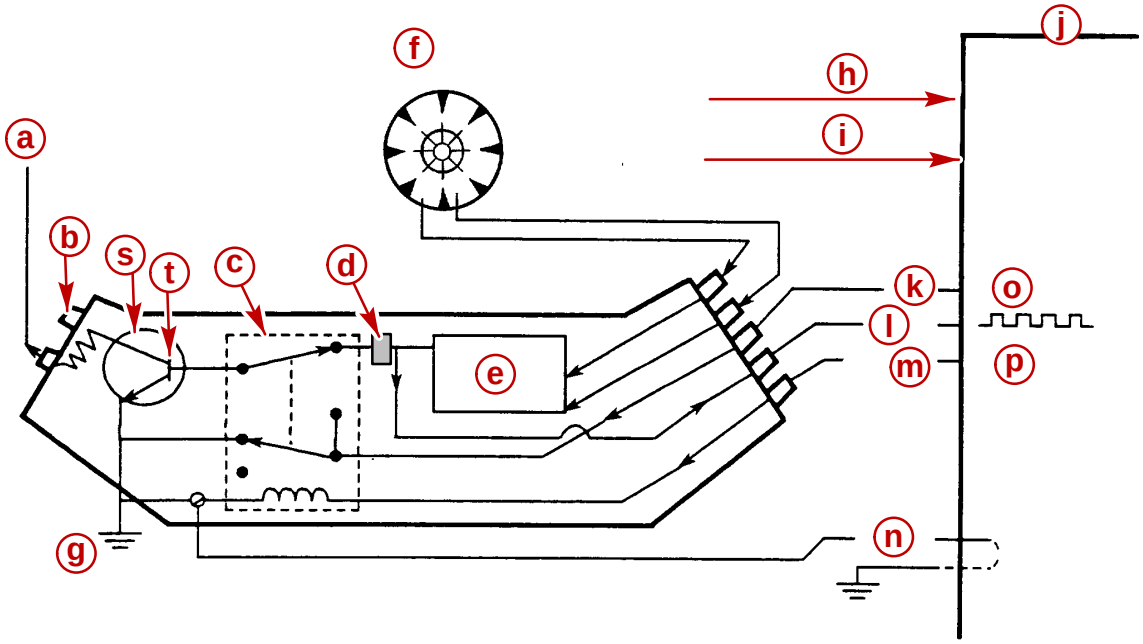
The ECM control mode controls the ignition timing. The ECM calculates the desired ignition timing based on information it gets from its input sensors.

(MEFI 1) When the engine rpm reaches a predetermined value (for this example, 300 rpm), the ECM considers the engine running and applies five volts on the bypass line to the IC module. This energizes the relay and causes the contacts from the pickup coil as well as the grounding contacts for the IC line to open (see figure “ECM Control Mode”). This connects the IC line to the base of the transistor, and bypasses the ignition module timing control.

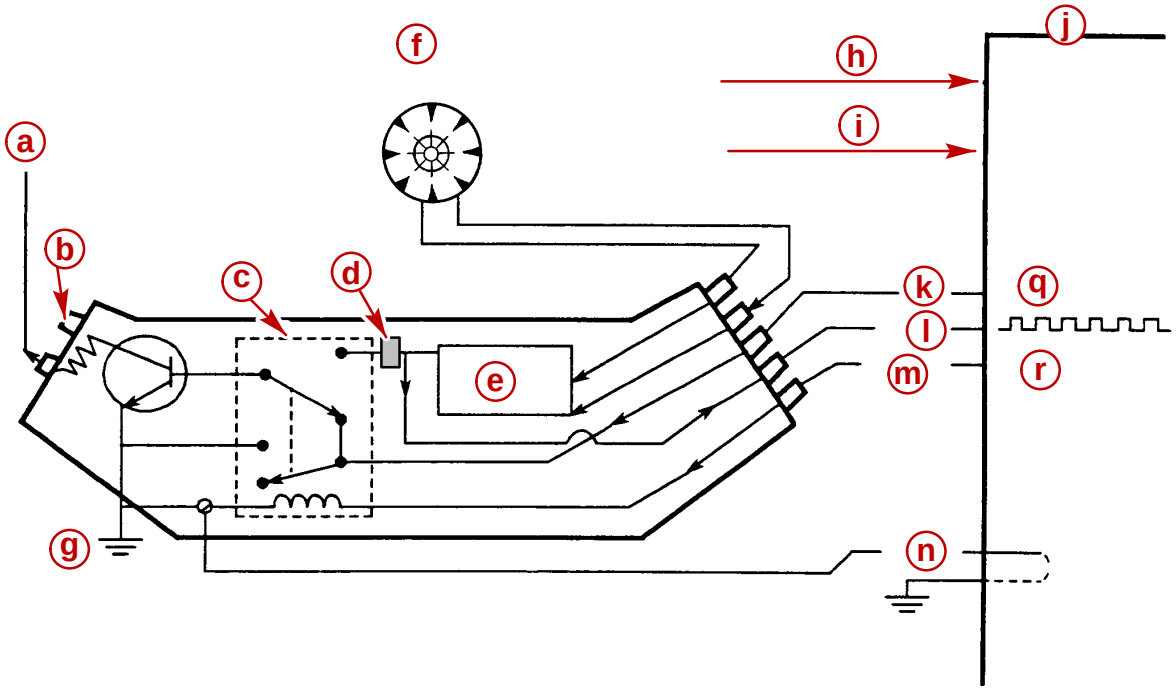
The IC system is now controlled by the IC signal from the ECM and the time at which the spark occurs can be determined by a variable time circuit in the ECM.

Base Ignition Timing

In order to check or change base timing on a EFI system the ECM has to be entered into the service mode by using a scan tool or code tool. The ECM will stabilize timing to allow timing adjustment. The ECM incorporates a spark control override, which allows timing to be lowered if spark knock (detonation) is encountered during normal operation. At this time, the timing can be adjusted by turning the distributor.



Distributor Module Mode



ECM Control Module

Base Ignition Timing (Continued)

a - Ignition Coil Trigger Signal
b - Battery
c - Relay
d - Module Advance
e - Signal Converter
f - Pick Up Coil
g - Ground
h - Manifold
i - Coolant Temperature
j - ECM
k - IC
l - REF HI
m - Bypass
n - REF LO
o - Grounded
p - No Voltage Applied
q - Not Grounded
r - Voltage Applied

Results of Incorrect Operation

Open IC Line from the ECM to the Distributor Module - While the engine is cranking, the ECM expects to see the IC signal pulled to virtually zero because it is grounded in the distributor module. Since the IC line is open, it cannot be grounded by the module and the IC signal will be able to rise and fall, or do what is called toggling. The ECM recognizes the toggling as an abnormal condition, and will not apply bypass voltage to the distributor module when the engine reaches run rpm.

Since bypass voltage is not applied to the relay, it remains open and the engine continues to run on the pickup coil triggering in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will stop, but it will restart and run in the ignition module timing mode with reduced power.

Grounded IC Line - During cranking, the IC voltage is at virtually zero so the ECM does not recognize a problem. When engine rpm reaches the value for the run condition, the ECM applies bypass voltage to the distributor module. Bypass voltage on the module switches the distributor power transistor to the IC line. Because the IC line is grounded, it will have no voltage applied so it cannot operate the power transistor to enter the IC mode.

If the IC line becomes grounded while the engine is being operated, the engine will stop and will be difficult to restart.

An open or ground in the IC or bypass will cause the engine to run on the distributor module timing. This will cause reduced performance, poor fuel economy and erratic idle.

Grounded or Open Bypass Line - While the engine is cranking, the IC line will be grounded and the ECM will not notice anything abnormal. When run rpm is reached, the ECM applies bypass voltage to the bypass line but because of the ground or open, it will not be able to energize the relay. Therefore, the relay will stay de-energized and the IC line will remain grounded.

When the ECM sees the IC line not toggling, it will not enter the IC mode. Since the relay is de-energized, the engine will continue to run in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will simply operate in the ignition module timing mode.

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Open or Grounded REF HI Line - This line provides the ECM with engine speed information. If this line is open or grounded, the ECM will not know that the engine is cranking or running and will not run.

Open or Grounded REF LO Line - This wire is grounded in the ignition module and provides a reference ground from the ignition module to the ECM. The ECM compares reference ground with reference high voltage. If this circuit is open, or grounded at any other location than through the module, it may cause poor performance.

Fuel Metering System

General Description

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. The fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder (MPI) or from two injectors mounted on top of the intake manifold (EFI).

Cool Fuel Systems

This system was used on later MerCruiser MEFI-1 and MEFI-3 ECM engines. This system has a fuel cooler and the electric fuel pump inside a box on the lower, port side of the engine. The fuel regulator for this system is mounted on the fuel cooler.

Early versions of the MEFI-1 systems had a second regulator mounted in the fuel rail. This regulator does not control system fuel pressure. It is used to dampen fuel system pulsation only. Later versions of the MEFI-1 and the MEFI-3 have this regulator removed from the fuel rail.

Modes of Operation

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called modes. All the modes are controlled by the ECM and are described below.

STARTING MODE

When the ignition switch is turned to the crank position, the ECM turns ON the fuel pump relay and the fuel pump builds up pressure. The ECM then checks the Engine Coolant Temperature (ECT) sensor and Throttle Position (TP) sensor and determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned ON and OFF. This is done by pulsing the injectors for very short times.

CLEAR FLOOD MODE

If the engine floods, it can be cleared by opening the throttle half way (50%). The ECM discontinues fuel injector pulsation as long as the throttle is between 50 to 75 % and the engine rpm is below 300. If the throttle position becomes more than 75% or less than 50%, the ECM returns to the starting mode.

RUN MODE

When the engine is started and rpm is above 300, the system operates in the run mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: rpm, Manifold Absolute Pressure (MAP) sensor, and Engine Coolant Temperature (ECT) sensor . Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

ACCELERATION MODE

The ECM looks at rapid changes in Throttle Position (TP) and provides extra fuel by increasing the injector pulse width.

FUEL CUTOFF MODE

No fuel is delivered by the injectors when the ignition is OFF, to prevent dieseling. Also, fuel pulses are not delivered if the ECM receives no distributor reference pulses, which means the engine is not running. The fuel cutoff mode is also enabled at high engine rpm, as an overspeed protection for the engine. When cutoff is in effect due to high rpm, injection pulses will resume after engine rpm drops slightly.

DECELERATION MODE

The IAC is similar to a carburetor dashpot. It provides additional air when the throttle is rapidly moved to the idle position to prevent the engine from dying.

REV-LIMIT MODE

A fuel cutoff function is enabled at higher engine rpm. When the ECM senses that the engine has exceeded its specified maximum rpm, no fuel is delivered by the injectors. After the rpm drops below the specified maximum rpm, the ECM will resume fuel delivery.

MEFI-3 LOAD ANTICIPATION MODE

The Load Anticipation mode is available on MIE inboard engines only. The function is used to help inboard engines during shifting. An electrical signal from the neutral safety switch (on the transmission) is used to tell the ECM if the switch is closed or open. In neutral gear, the neutral safety switch is closed (signal grounded). When shifting into gear, the switch opens (signal open).

When the transmission is shifted into gear, the open signal causes the ECM to add a calibrated amount of bypass air with the IAC. This is done to increase the load handling capability of the engine when going into gear on larger boats. When shifting back into neutral gear, the additional IAC bypass air is removed in an attempt to limit engine rpm flares. The amount of IAC air used is constantly monitored by the ECM. After the transmission is shifted, and the engine has stabilized, the ECM calculates an ‘error band’ from the Moving Desired rpm mode and adjusts the Load Anticipation mode IAC count accordingly. This allows the ECM to ‘learn’ the best IAC bypass air position to use for shift conditions in each particular boat.

MOVING DESIRED RPM MODE

IMPORTANT: An improperly adjusted throttle cable can cause the engine idle rpm to be higher than the normal 600 rpm even when the control lever returns to the idle rpm position.

A Moving Desired RPM mode has been added to the MEFI 3 ECM. this mode will increase the desired idle rpm to a calibrated set point according to the throttle position. When the Throttle Position (TP) sensor is at the closed throttle setting, the ECM will use Idle Air Control (IAC) and Ignition Control (IC) to maintain the calculated desired rpm. This will smooth the transition from idle (closed throttle) to higher throttle settings. It will also help maintain constant low engine speeds from approximately 600 to 1200 rpm. At 5% or greater TP sensor setting, the Moving Desired RPM mode is not active.

Throttle Body Injection Components

FUEL PUMP ELECTRICAL COMPONENTS

When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

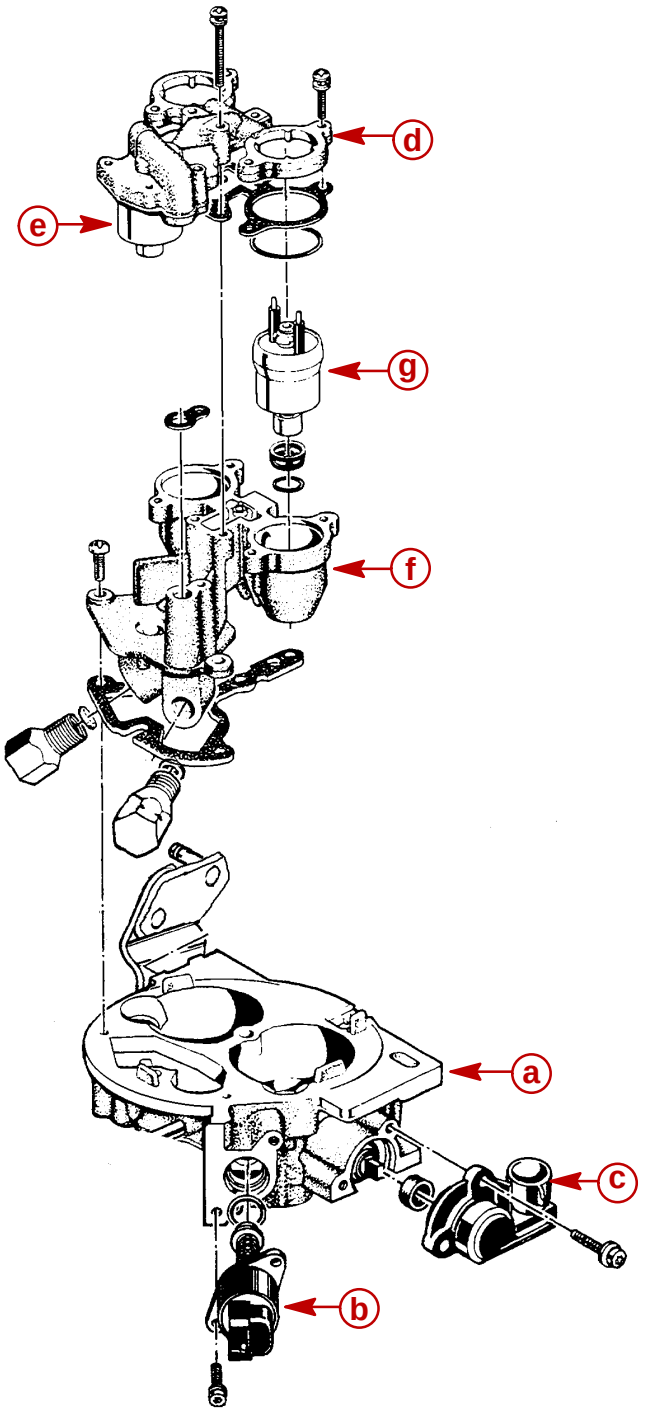
If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts Off the fuel pump relay, causing the fuel pump to stop.

THROTTLE BODY UNIT

The throttle body unit consists of three assemblies.

- Fuel meter cover and fuel damper
- Fuel meter body and fuel injectors
- Throttle Body
  - -Two Throttle Valves To Control Air Flow Into The Engine
  - -Idle Air Control (IAC) Valve
  - -Throttle Position (TP) Sensor

THROTTLE BODY UNIT EXPLODED VIEW



73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - Throttle Position (TP) Sensor
d - Fuel Meter Cover
e - Fuel Damper
f - Fuel Meter Body
g - Fuel Injector (2)

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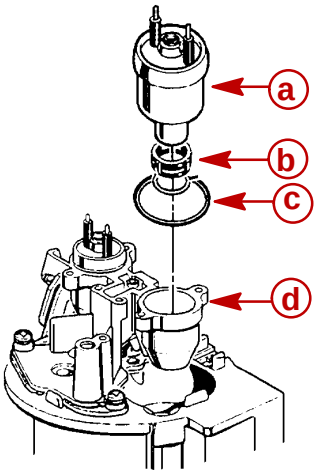
FUEL INJECTORS

The injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to the intake manifold. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.

The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the throttle, causing it to become further atomized before entering the intake manifold.

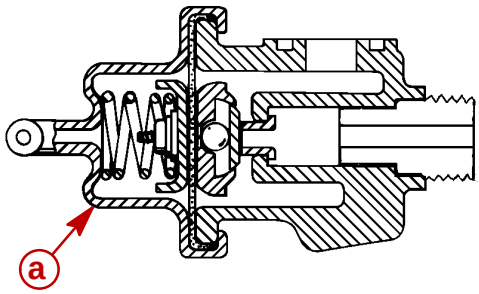


73773

a - Fuel Injector
b - Fuel Filter
c - Seal Ring
d - Fuel Meter Body

FUEL PRESSURE REGULATOR

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. The regulator is located on the cool fuel assembly. Refer to "Fuel Delivery System for Electronic Fuel Injection" Section of this manual.



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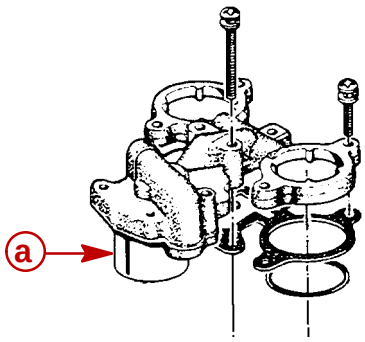
a - Fuel Pressure Regulator

FUEL DAMPER

The fuel damper acts as an equalization device to reduce the pressure spikes caused by the fuel injectors.

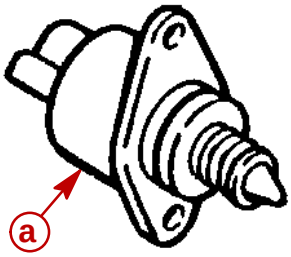


76499

a - Fuel Damper

IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



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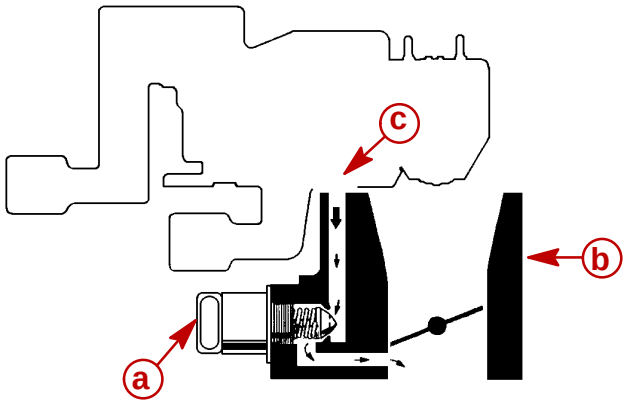

IAC Valve Air Flow Diagram

a - IAC Valve
b - EFI Throttle Body
c - Air Flow

By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If rpm is too low, more air is bypassed around the throttle valve to increase it. If rpm is too high, less air is bypassed around the throttle valve to decrease it.

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The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC.

During idle, the proper position of the IAC valve is based on engine rpm. If the rpm drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position + throttle valve stop screws and PCV.
- “Controlled” idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during “controlled” idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: turn off engine, wait ten seconds, and restart engine.

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FUEL SYSTEM

Section 5G - Fuel Injection Disassembly And Reassembly

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5 G

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠ WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠ WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠ CAUTION

Fuel pressure MUST BE relieved before servicing high pressure component in the fuel system.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

The following information MUST BE adhered to when working on the fuel system:

- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel pipe fittings.**
- **DO NOT replace fuel pipe with fuel hose.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Notes and Cautions.**

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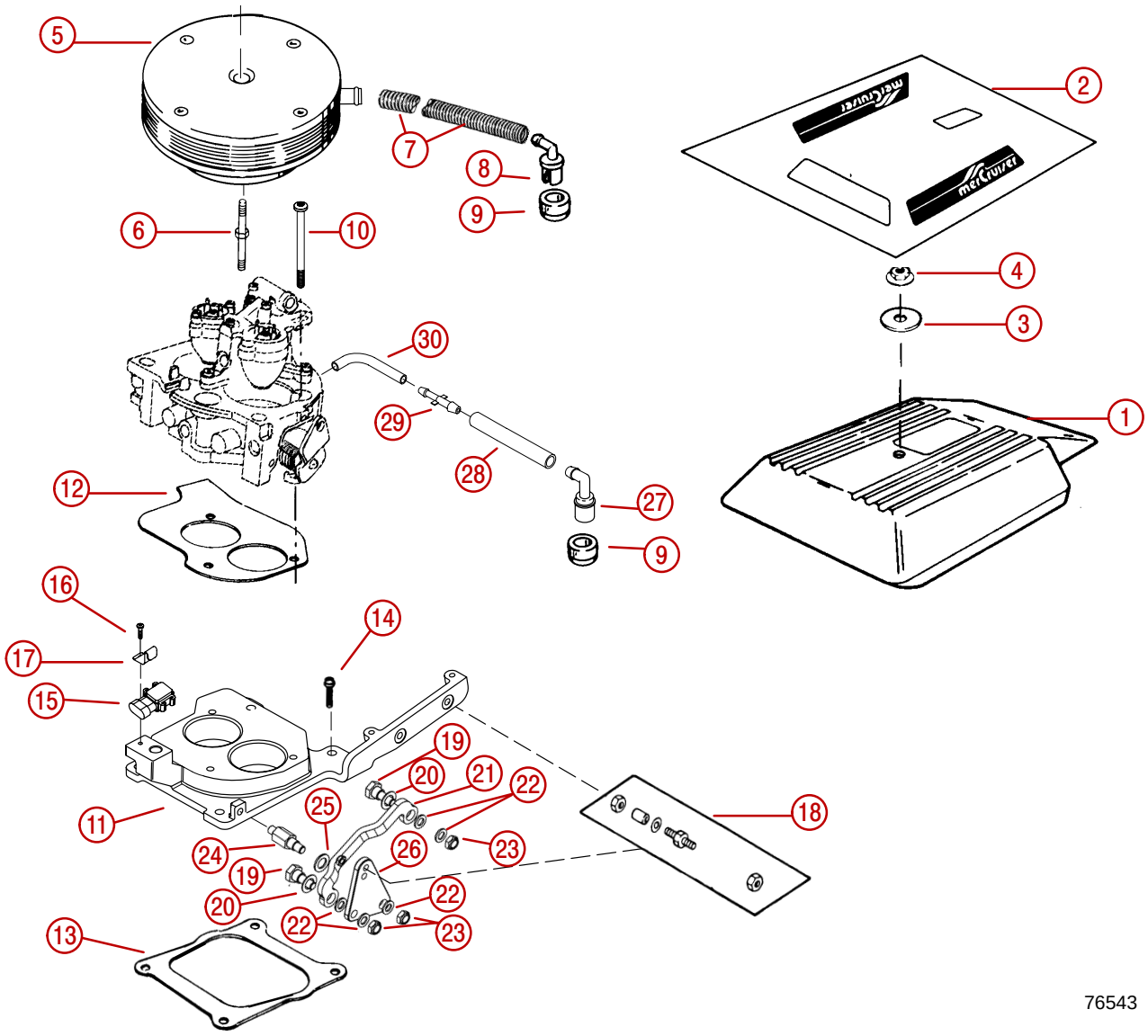
Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Throttle Body to Adapter		15	19
TP Sensor	20		2
IAC Valve	20		2
MAP Sensor	44-62		5-7
Knock Sensor to Block		12-16	16.3-21.7
Intake Manifold to Plenum	150		17
Fuel Line Connections		18	24
Fuel Meter Cover Assembly Screws	28		3
Fuel Inlet and Return Lines		23	31
ECT Sensor	Hand Tight + 2 1/2 turns maximum		
Flame Arrestor Cover Bracket	Tighten Securely		
Flame Arrestor Clamp			

Flame Arrestor And Throttle Body



1 - Cover
2 - Decal Set
3 - Washer
4 - Nut (1/4-20)
5 - Flame Arrestor
6 - Stud
7 - Breather Hose
8 - Elbow (90 degree)
9 - Grommet
10 - Screw (5/16-18 x 2-1/4 in.)
11 - Adapter Assembly - TBI
12 - Gasket
13 - Gasket
14 - Screw (5/16-18 x 3/4 in.)
15 - Map Sensor
16 - Screw (#10-24 x 1/2 in.)
17 - Clip
18 - Stud Kit
19 - Bolt
20 - Washer
21 - Connector
22 - Washer
23 - Nut (5/16-24)
24 - Shaft
25 - Washer
26 - Plate
27 - Valve - PVC
28 - Hose - PVC (3\8 in I.D.)
29 - Connector
30 - Hose (7/32 in. I.D.)

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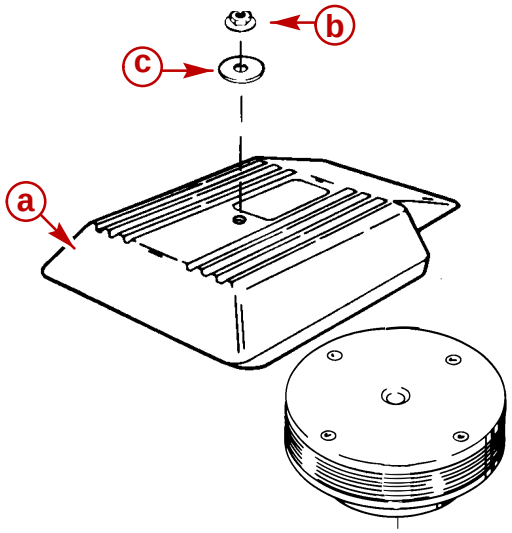
REMOVAL

NOTICE
Refer to “Precautions” at front of this section BEFORE proceeding.

1. Remove the flame arrestor cover.



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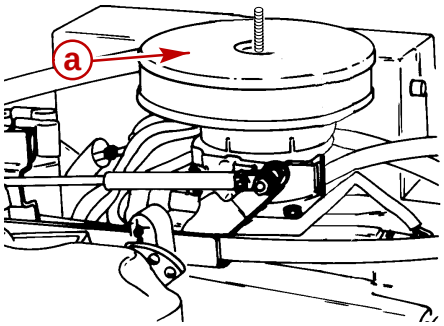
a - Flame Arrestor Cover
b - Nut
c - Washer

2. Remove the flame arrestor.



76501

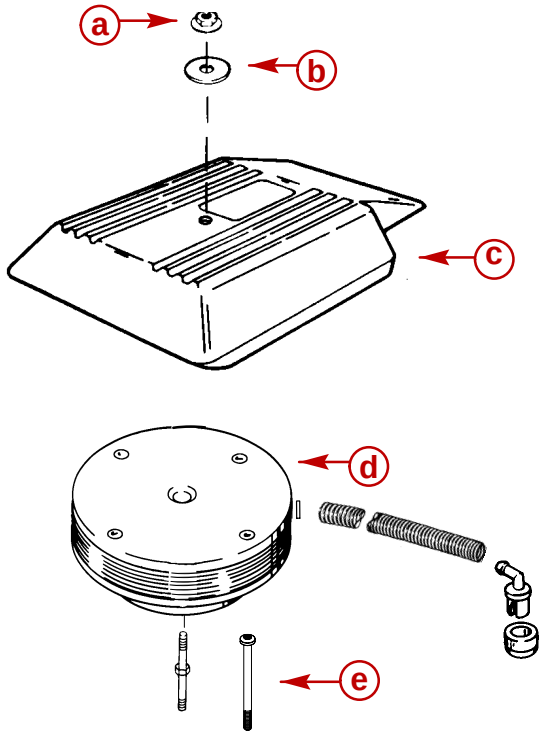
a - Flame Arrestor

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent.
2. Wear eye protection. Dry flame arrestor with compressed air.

INSTALLATION

1. Replace components. Tighten all fasteners securely.

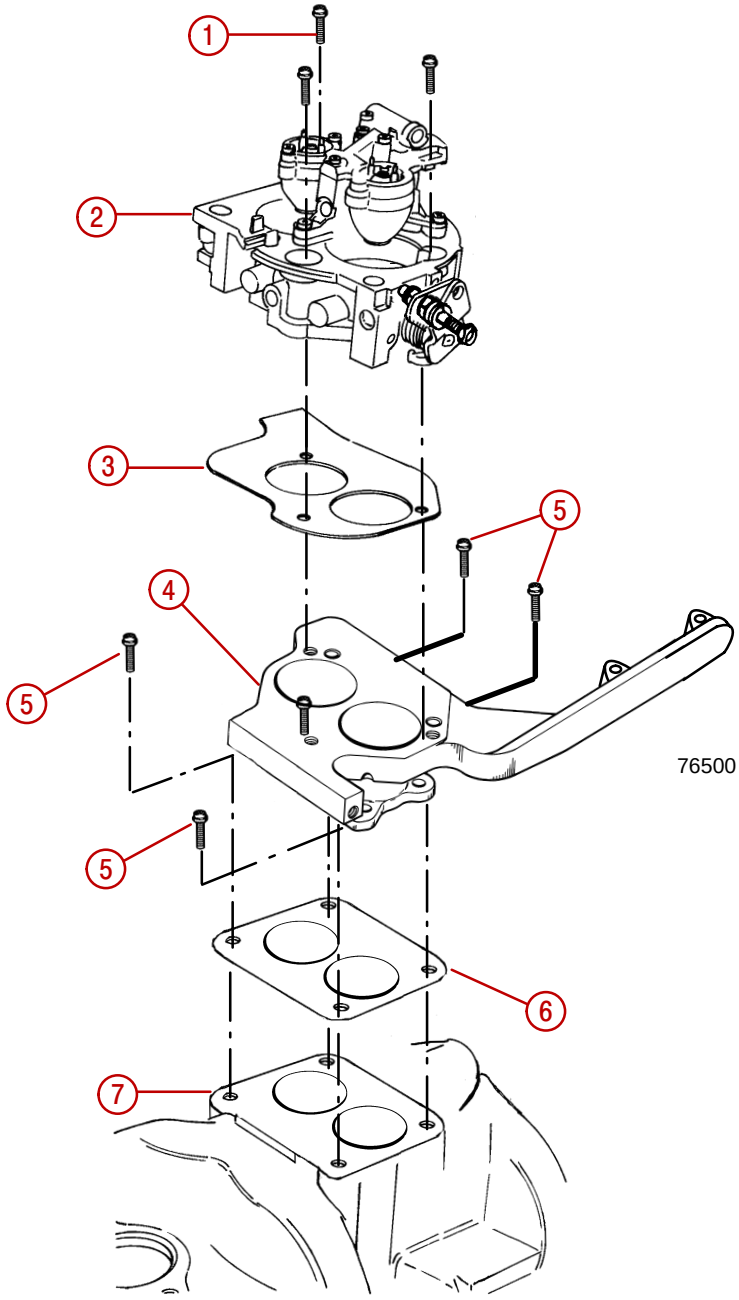


76543

a - Nut
b - Washer
c - Flame Arrestor Cover
d - Flame Arrestor
e - Stud

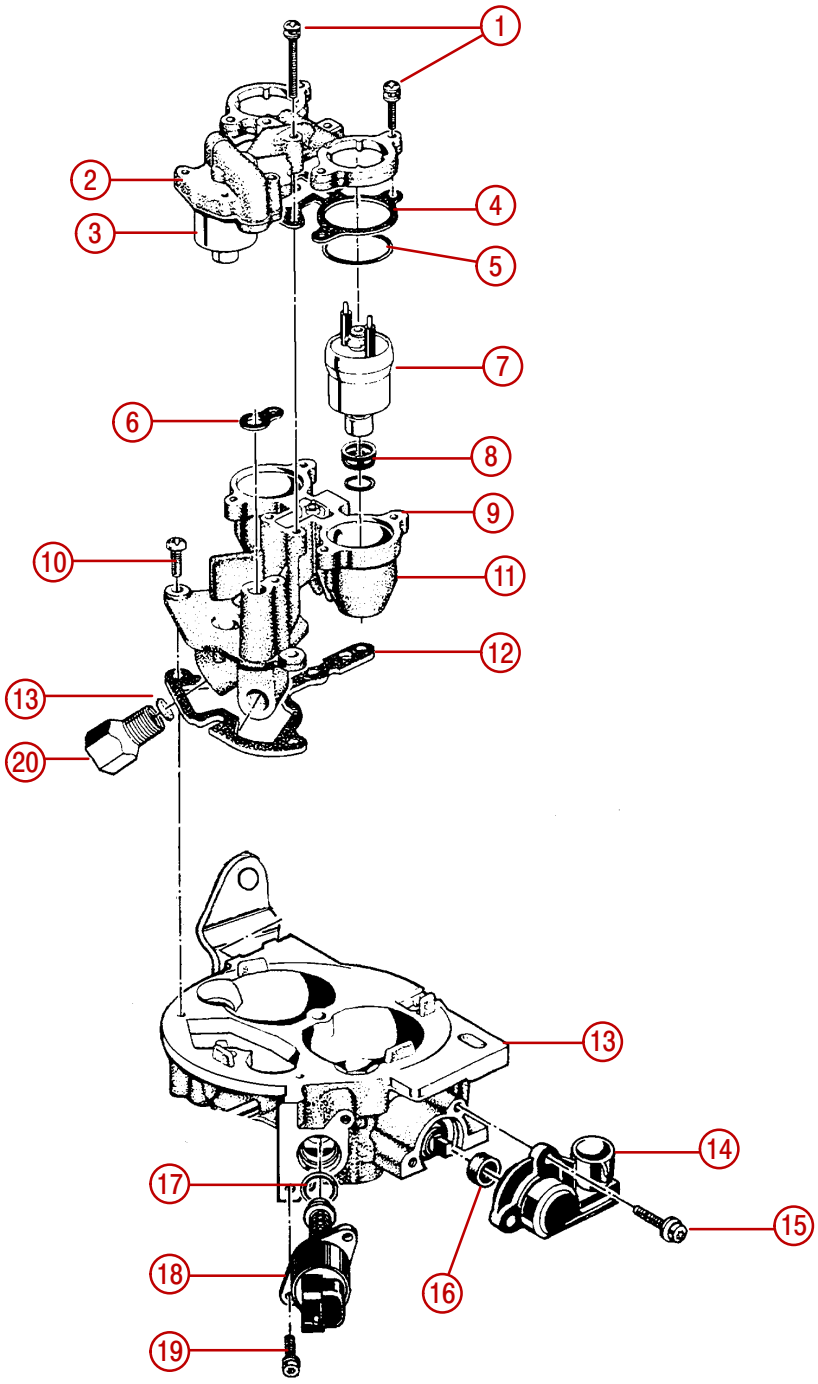
Exploded Views - Throttle Body EFI

Throttle Body Body And Adapter



1 - Throttle Body
2 - Screws (3)
3 - Gasket
4 - Throttle Body Adapter
5 - Screws (4)
6 - Gasket
7 - Intake Manifold

Throttle Body Assembly



1 - Cap Screw
2 - Cover Assembly
3 - Fuel Pressure Regulator
4 - Cover Assembly Gasket
5 - Upper O-Ring
6 - Fuel Meter Outlet Gasket
7 - Fuel Injector (2)
8 - Fuel Filter (2)
9 - Lower O-Ring
10 - Screw
11 - Body
12 - Throttle Body To Fuel Meter Body Gasket
13 - Throttle Body
14 - Throttle Position (TP) Sensor
15 - Screws (2)
16 - Seal
17 - O-Ring
18 - Idle Air Control (IAC) Valve
19 - Screws (2)
20 - Fuel Inlet

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Fuel Pressure Relief Procedure

NOTICE
Refer to “Precautions” in front of this section BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

Throttle Body EFI Components

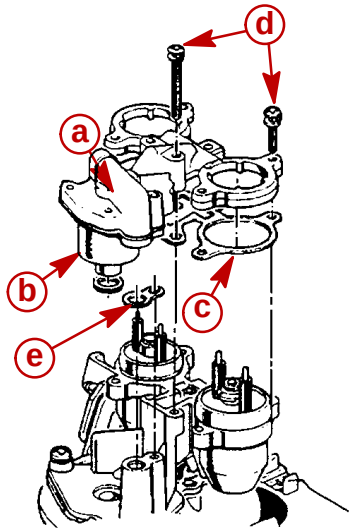
Fuel Meter Cover Assembly

NOTICE
Refer to “Precautions,” at front of this section BEFORE proceeding.

⚠ CAUTION
DO NOT remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury.

REMOVAL

1. Remove the flame arrestor from the throttle body.
2. Disconnect electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
3. Remove the fuel meter cover screw assemblies.
4. Remove fuel meter cover assembly.



73767

a - Fuel Meter Cover
b - Fuel Damper
c - Gaskets (Regulator Passages)
d - Screws
e - Fuel Meter Outlet Gasket

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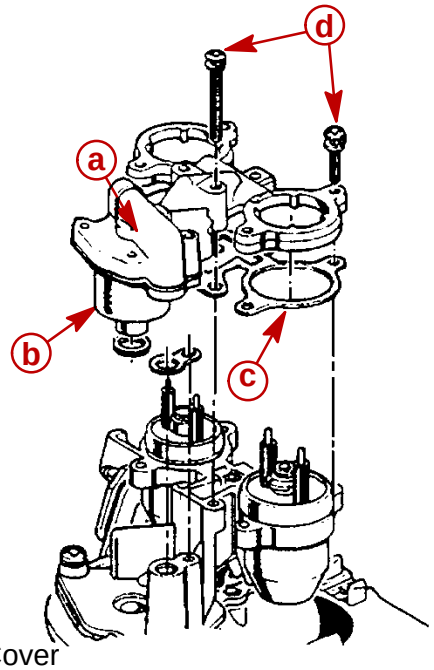
CLEANING AND INSPECTION

IMPORTANT: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

1. Inspect pressure regulator seating area for damage. Use a magnifying glass if necessary. If damaged, replace the cover assembly.

INSTALLATION

1. Install new pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Install fuel meter cover assembly.
3. Install attaching screws, precoated with appropriate locking compound to threads. (Short screws are next to injectors.)
4. Torque screws to 28 lb-in. (3 Nm).
5. Connect electrical connectors to fuel injectors.
6. With engine OFF, and ignition ON, check for leaks around gasket and fuel line couplings.



73767

a - Fuel Meter Cover
b - Pressure Regulator Assembly
c - Gaskets (Regulator Passages)
d - Screws

Fuel Injectors

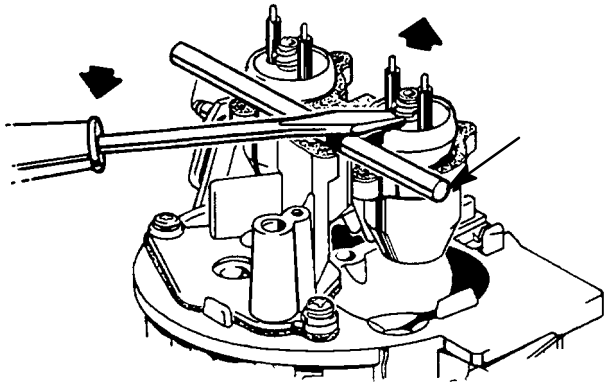
NOTICE
Refer to “Precautions” at front of this section BEFORE proceeding.

REMOVAL

NOTE: *Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.*

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor and fuel meter cover as outlined in this section.
2. Using a screwdriver carefully pry up on fuel injector to remove it from the fuel meter body (Use a screwdriver or rod under the the screwdriver when prying up. Leave old gasket in place to prevent damage to fuel meter body).



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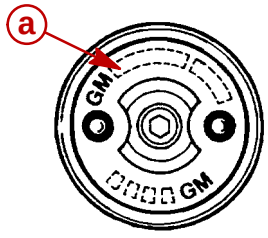
CLEANING AND INSPECTION

Inspect fuel injectors for damage; replace if necessary.

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.



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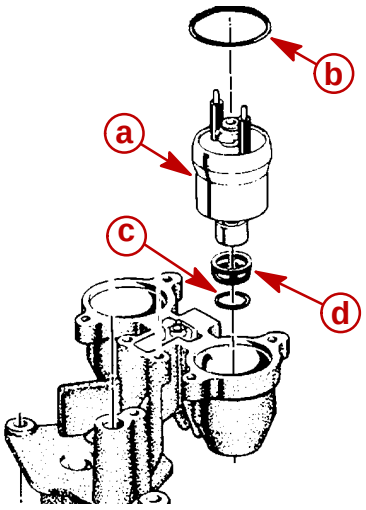
a - Part Indentification Number

INSTALLATION

1. Install new lower O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



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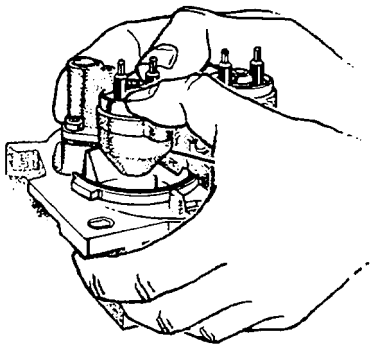
a - Fuel Injector
b - Upper O-Ring
c - Lower O-Ring
d - Fuel Filter

2. Install upper O-rings in fuel meter body. Lubricate O-rings with water soap solution.
3. Install fuel injectors into the fuel meter body. Align the raised lug on the injector base with the notch in fuel meter cavity.



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NOTE: *The electrical terminals of the injectors should be parallel with throttle shaft.*

4. Install gasket and fuel meter cover, torque screws to 28 lb-in. (3 Nm) and flame arrestor as outlined in this section.
5. Connect electrical connections to fuel injectors.
6. With engine OFF, and ignition ON, check for leaks around gasket and fuel line couplings.

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Throttle Body

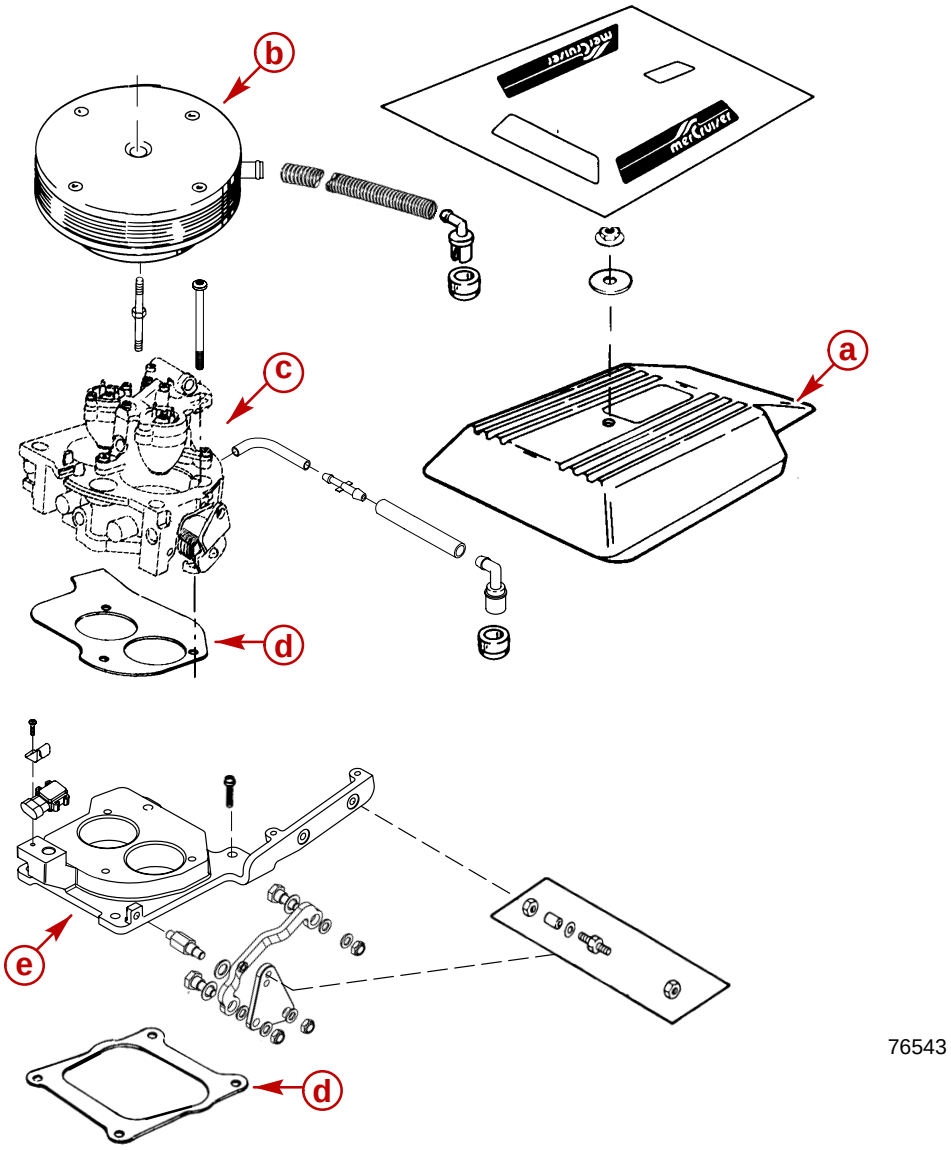
REMOVAL

⚠ CAUTION

Ensure that fuel pressure is relieved before removing the fuel inlet and return lines.

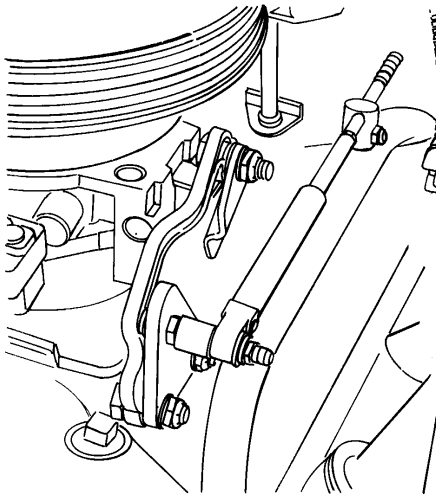
IMPORTANT: DO NOT allow the TP sensor, fuel pressure regulator, fuel injectors and IAC valve to come into contact with solvent or cleaner. These components should be removed prior to immersion in solvent.

1. Remove the flame arrestor from the throttle body.



a - Flame Arrestor Cover
b - Flame Arrestor
c - Throttle Body Unit
d - Gasket
e - Throttle Body Adapter

2. Disconnect throttle cable.



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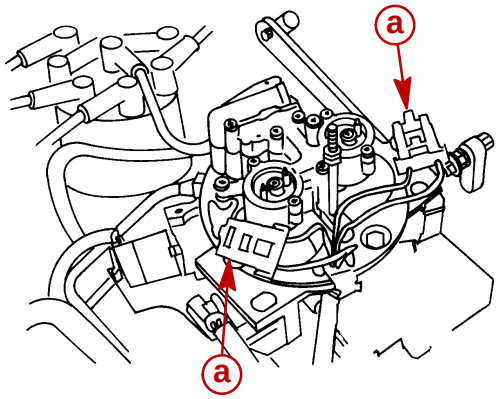
3. Disconnect the electrical connections from the TP sensor, IAC and fuel injectors. (Squeeze plastic tabs on injectors and pull straight up).



73750

a - Electrical Connections

4. Remove fuel inlet and outlet lines from throttle body.
5. Remove screws retaining the throttle body to adapter plate.

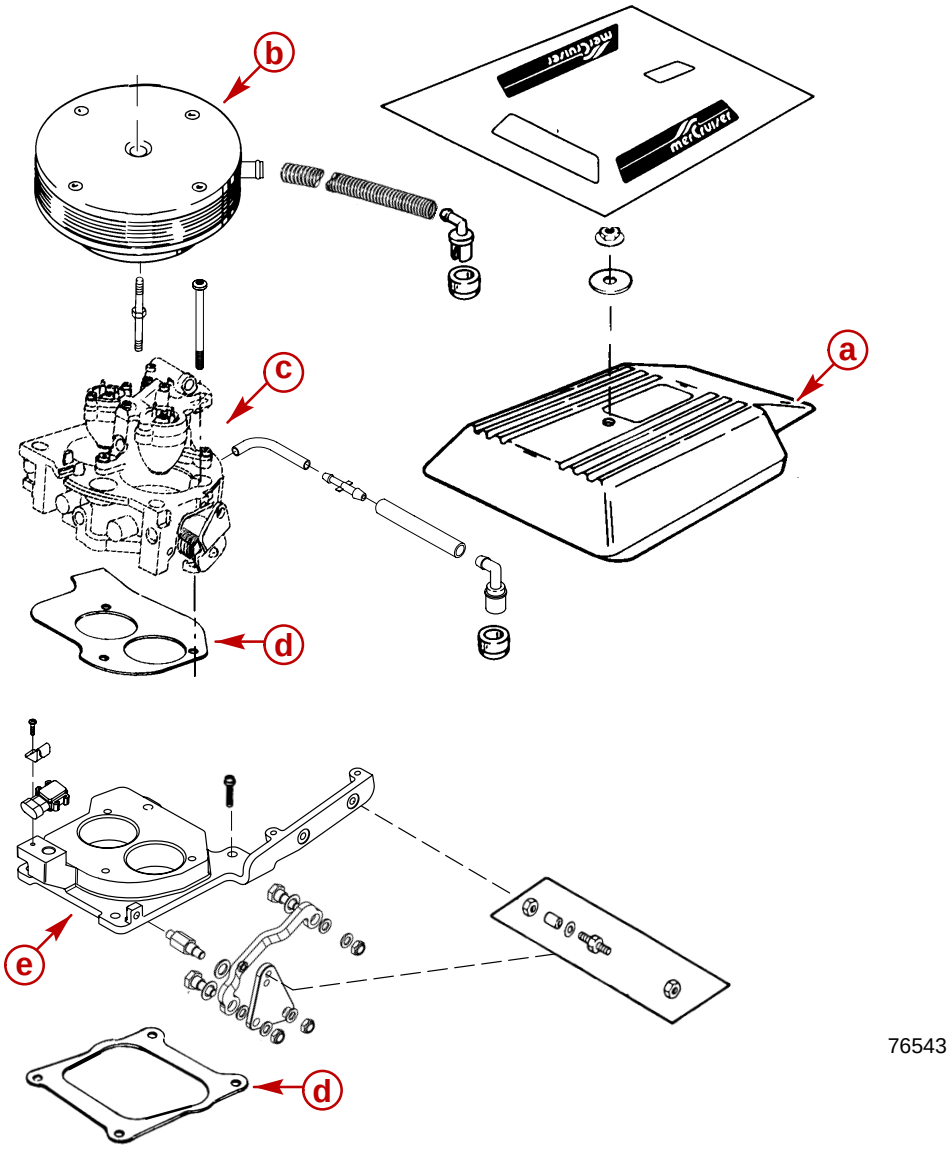
NOTE: *Place a shop rag over the intake manifold opening to prevent debris from entering intake manifold.*

CLEANING AND INSPECTION

1. Thoroughly clean metal parts of throttle body in a cold immersion type cleaner. Dry with compressed air. Make certain that all passages are free of dirt and burrs.
2. Inspect mating surfaces for damage that could affect gasket sealing.
3. Inspect throttle body for cracks in casting.
4. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
5. Check intake manifold plenum for loose parts and foreign material.

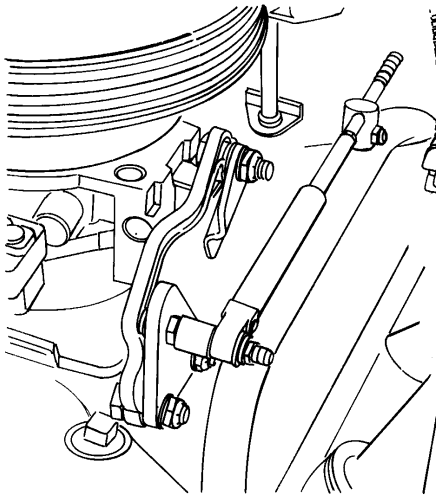
INSTALLATION

1. Install fuel injectors and fuel meter body.
2. Install a new gasket on adapter plate.
3. Install throttle body on adapter plate and torque the screws 30 lb-ft (40 Nm).



a - Flame Arrestor Cover
b - Flame Arrestor
c - Throttle Body Unit
d - Gasket
e - Throttle Body Adapter

4. Connect throttle linkage to throttle body.



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5. Move throttle from idle to WOT and check that the throttle movement is not binding.
6. Connect the fuel inlet and return lines. Torque to 23 lb-ft (31 Nm).
7. Connect TP sensor, IAC, and fuel injectors connections.
8. Turn key to ON position and check for fuel leaks around the inlet and return line connections.
9. Start engine and check for fuel leaks.

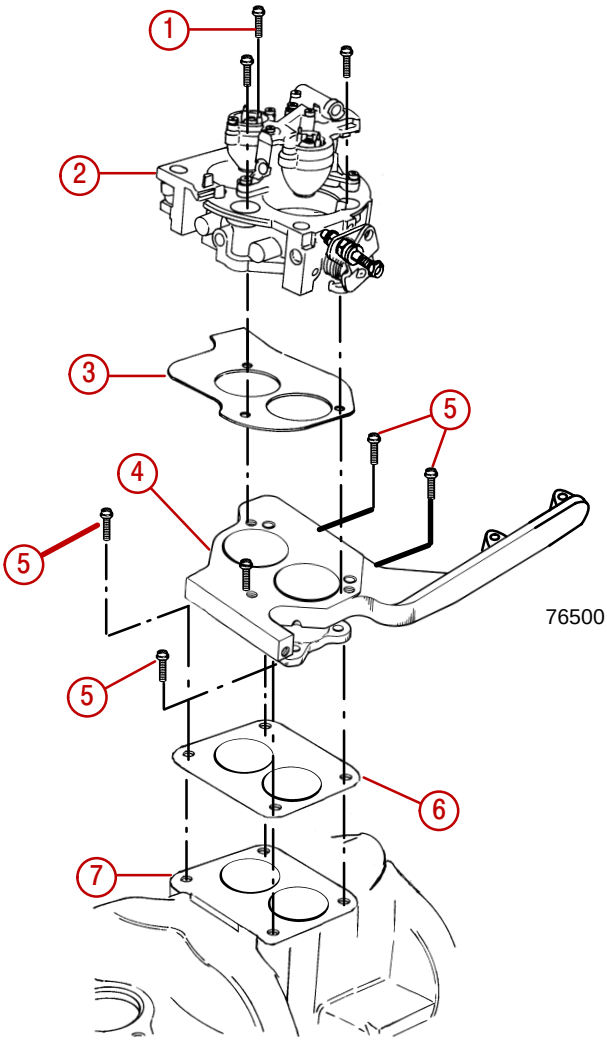
Throttle Body Adapter Plate

NOTICE
Refer to “Service Precautions” at front of this section BEFORE proceeding.

REMOVAL

IMPORTANT: Place a clean shop towel over the intake manifold opening to prevent foreign material from entering the engine.

1. Remove flame arrestor.
2. Remove throttle body.
3. Remove screws and throttle body adapter from the intake manifold.



Typical

1 - Throttle Body
2 - Screws (3)
3 - Gasket
4 - Throttle Body Adapter
5 - Screws (4)
6 - Gasket
7 - Intake Manifold

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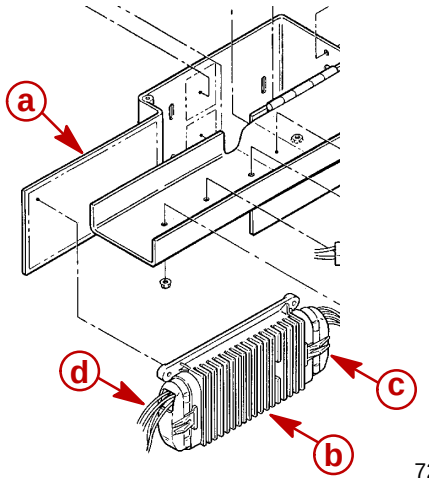
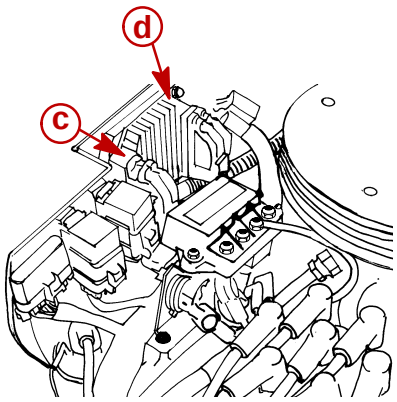
Engine Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.



72801



76253

MEFI 1 **MEFI 3**

NOTE: *Connectors are reversed between MEFI 1 and MEFI 3.*

- **a -** Electrical Bracket
- **b -** ECM
- **c -** J1- Electrical Connector
- **d -** J2- Electrical Connector

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).
2. Remove ECM from electrical bracket.

CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed of the harness.

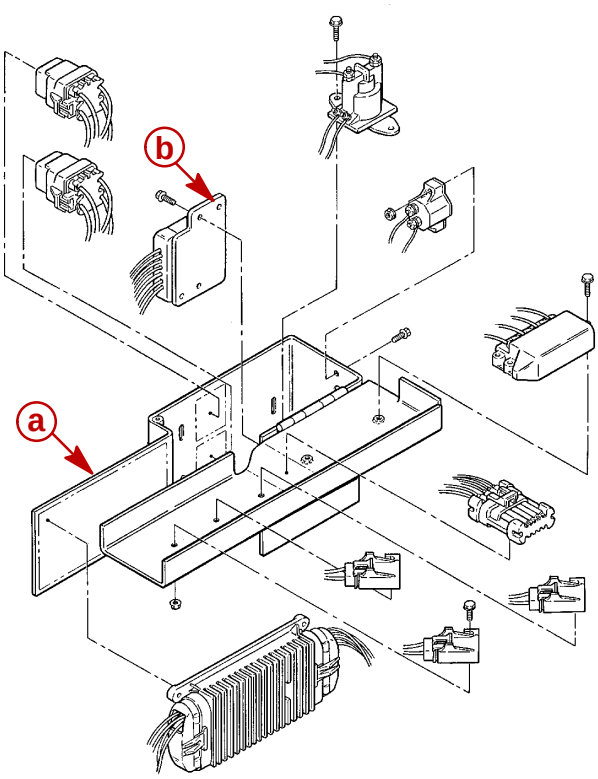
NOTE: *The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.*

INSTALLATION

1. Mount new ECM to electrical bracket.
2. Connect J1 and J2 electrical connectors to the ECM.

Knock Sensor (KS) Module (MEFI 1 Only)

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.



72801

MEFI 1

a - Electrical Bracket
b - Knock Sensor (KS) Sensor

REMOVAL

1. Remove Knock Sensor from electrical bracket.
2. Disconnect electrical connector at Knock Sensor (KS) Module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS Module with a dry cloth.
2. Inspect surfaces of KS Module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the Knock Sensor (KS) Module.
2. Mount KS Module to electrical bracket.

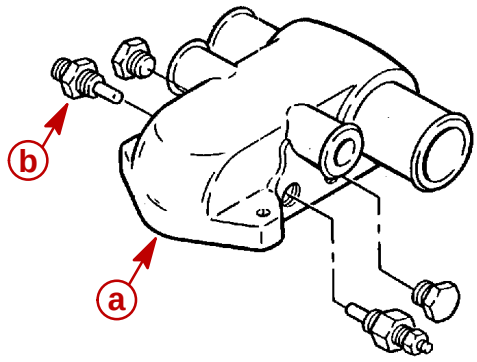
Engine Coolant Temperature (ECT) Sensor

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.

REMOVAL

NOTE: *Handle the ECT carefully as any damage to it will affect operation of the system.*

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) Sensor.



72799

a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

2. Remove ECT from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT.

INSTALLATION

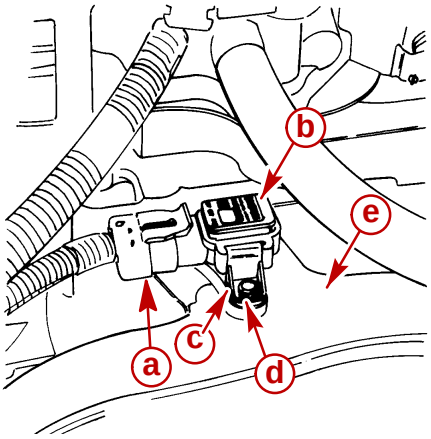
1. Install ECT in thermostat housing. Tighten hand tight plus 2-1/2 turns maximum.
2. Connect electrical connector to ECT.

Manifold Absolute Pressure (MAP) Sensor

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector from Manifold Absolute Pressure (MAP) Sensor.



75840

a - Electrical Connector
b - Manifold Absolute Pressure (MAP) Sensor
c - Clip
d - Screw
e - Intake Manifold

2. Remove MAP sensor from throttle body adapter.

CLEANING AND INSPECTION

1. Clean the surfaces of the MAP sensor with a dry cloth.
2. Inspect the MAP sensor for signs of wear or damage.
3. Inspect seal on MAP sensor. Replace if deteriorated or hardened.

INSTALLATION

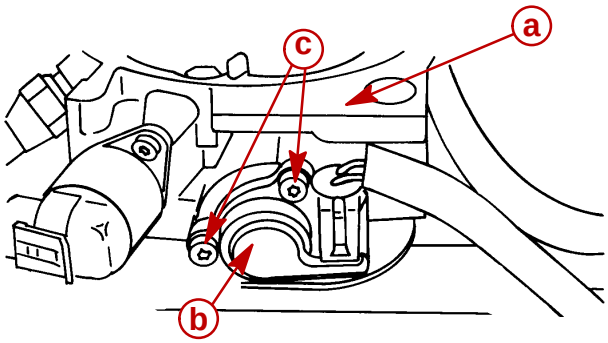
1. Install seal on MAP sensor.
2. Install MAP sensor on intake manifold using clip and screw. Torque screw to 44-62 lb-in. (5-7 Nm).
3. Connect electrical connector to MAP sensor.

Throttle Position (TP) Sensor

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at Throttle Position (TP) Sensor.
2. Remove TP sensor from throttle body.



73758

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws

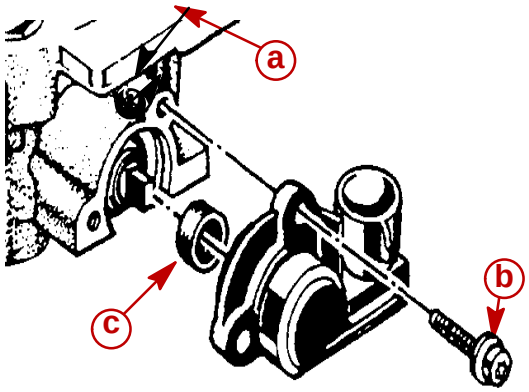
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws that are included in the service package.

1. Install TP sensor to throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb-in. (2 Nm).



73758

a - Throttle Body
b - Screws With Lockwashers
c - Seal

2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor. Refer to “Throttle Body.”
4. Start engine and check for TP sensor output voltage. It should be approximately .7 V at idle and 4.5 V at WOT.

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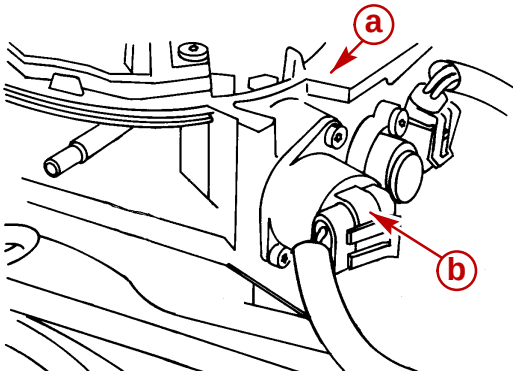
Idle Air Control (IAC) Valve

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body.
2. Disconnect electrical connector at Idle Air Control (IAC) Valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

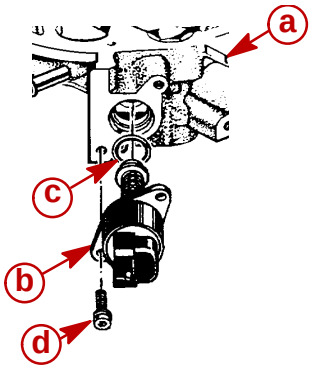
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

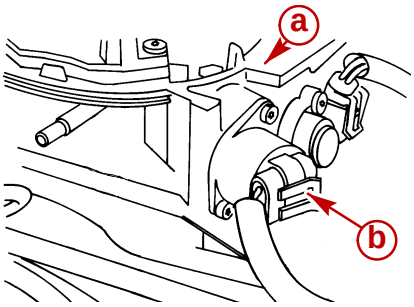
1. Install new O-ring on IAC valve.



73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

2. Install IAC valve in throttle body using screws. Torque to 20 lb-in. (2 Nm).
3. Connect electrical connector to IAC valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

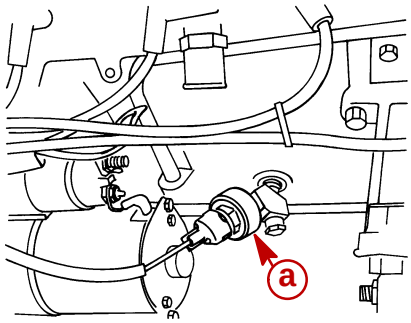
4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

Knock Sensor

NOTICE
Refer to “Service Precautions” at front of this section BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



73757

a - Knock Sensor

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

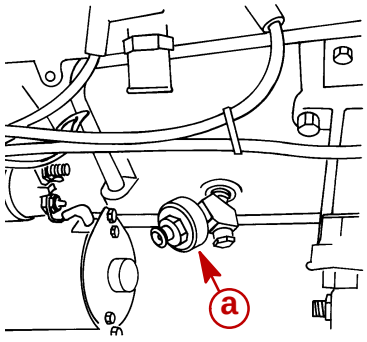
INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

IMPORTANT: Ensure that the knock sensor is installed in the upper location on the Y-fitting.

1. Install knock sensor in engine block. Torque to 12-16 lb-ft (16-22 Nm).



73756

a - Knock Sensor

2. Connect electrical connector to knock sensor.

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FUEL SYSTEMS

Section 5H - Fuel Injection System Troubleshooting

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5 H

Scan Tool Normal Specifications (Idle / Warm Engine / Closed Throttle / Neutral)

Scan Position	Units Displayed	Typical Data Value
rpm	rpm	600-700 rpm
Desired rpm	rpm	600 or 650 rpm - Depends on Model [2]
Coolant Temp.	° F(° C)	150-170° F (66-77° C)
Manifold Air Temp.	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5–3.5 msec. (Depends on Water/Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH(3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration and Check Sum	Varies with Software revision in ECM
Oil Press/IO Level [1]	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Lanyard Stop Mode	OFF/ON	OFF

[1]: MCM will read I/O Level and MIE will read Trans.

[2] : Refer to “Engine and Tune-Up Specifications.”

Important Preliminary Checks

Before Starting

Before using this section you should have performed the “On-Board Diagnostic (OBD) System Check” in the “General System Diagnostics” section and determined that:

- The ECM and/or MIL (Malfunction Indicator Lamp) are operating correctly.
- There are no DTC(s) stored.

Verify the customer complaint and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

Visual / Physical Check

Several of the symptom procedures call for a careful Visual/ Physical Check. The importance of this step cannot be stressed too strongly. It can lead to correcting a problem without further checks and can save valuable time. This check should include:

- Engine in good mechanical condition.
- ECM grounds and sensor connections for being clean, tight and in their proper location.
- Vacuum hoses for splits, kinks and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches and cuts. If wiring harness or connector repair is necessary, refer to “Description and System Operation” section for correct procedure.
- Moisture in primary or secondary ignition circuit connections.
- Salt corrosion on electrical connections and exposed throttle body linkages.

Intermittents

IMPORTANT: Problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a DTC. DO NOT use the Diagnostic Trouble Code (DTC) tables for intermittent problems. The fault must be present to locate the problem.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check. Check for the following conditions:

- Poor mating of the connector halves, or a terminal not fully seated in the connector body (backed out or loose).
- Improperly formed or damaged terminals and/or connectors.

All connector terminals in the problem circuit should be carefully checked for proper contact tension.

- Poor terminal to wire connection (crimping).This requires removing the terminal from the connector body to check. Refer to “Wiring Harness Service” in the “Description and System Operation” section.

The vessel may be driven with a Digital Multimeter connected to a suspected circuit. An abnormal voltage when malfunction occurs is a good indication that there is a fault in the circuit being monitored.

A scan tool (see “Special Tools” for part numbers) can be used to help detect intermittent conditions. The scan tools have several features that can be used to locate an intermittent condition. The following features can be used in finding an intermittent fault:

The “Record” feature or choosing not to erase data can be triggered to capture and store engine parameters within the scan tool when the malfunction occurs. This stored information can then be reviewed by the service technician to see what caused the malfunction.

To check loss of DTC memory, disconnect TP sensor and idle engine until the MIL comes ON. A trouble code should be stored and kept in memory when ignition is turned OFF. If not, the ECM is faulty. When this test is completed, make sure that you clear the DTC 22 from memory.

An intermittent MIL with no stored DTC may be caused by the following:

- Ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL wire to ECM shorted to ground.
- Poor ECM grounds, Go to ECM wiring diagrams.
- Check for an electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
- Check for improper installation of electrical options such as lights, ship to shore radios, sonar, etc.
- Check that knock sensor wires are routed away from spark plug wires, ignition system components and charging system components.
- Check for secondary ignition components shorted to ground, or an open ignition coil ground (coil mounting brackets).
- Check for components internally shorted to ground such as starters, alternators or relays.

All Ignition Control (IC) module wiring should kept away from the alternator. Check all wires from the ECM to the ignition control module for poor connections.

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Hard Start Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Does the driver know the correct starting procedure?***	Step 3	System normal
3	***Was visual/physical check performed?***	Step 4	Visual/Physical Check
4	1. Check for proper operation of fuel pump relay circuit. • *Refer to* Table A-5 in "General System Diagnostics" section. ***Was a problem found?***	OBD	Step 5
5	1. Check for contaminated fuel. 2. Check water separating fuel filter. ***Was a problem found?***	OBD	Step 6
6	1. Check for proper fuel pressure. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was fuel pressure 30 psi for EFI or 3-7 psi for carbureted engines?***	OBD	Step 7
7	1. Check for proper ignition voltage output. • *Refer to* Table A-7 in "General System Diagnostics" section. ***Was a problem found?***	OBD	Step 8
8	***Is a scan tool being used?***	Step 10	Step 9
9	1. Check for a ECT sensor shifted in value. 2. With engine completely cool, measure the resistance of the ECT sensor. 3. Refer to the Engine Coolant Temperature Sensor Temperature vs Resistance value table on the facing page of DTC 14 in the "Trouble Code Diagnostics" section. Compare the approximate temperature of the ECT sensor to an accurate reading of ambient air temperature. ***Are the readings within the specified value?***	Step 14	Step 13
10	1. Check ECT sensor for being shifted in value. 2. With the engine completely cool, compare the ECT sensor temperature with an accurate reading of ambient air temperature. ***Are the temperatures within 10° F (-12° C) of each other?***	Step 11	Step 13

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Hard Start Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
11	1. Using a scan tool, display ECT sensor temperature and note value. 2. Check resistance of ECT sensor. 3. Go to Engine Coolant Temperature Sensor Temperature vs Resistance value table on the facing page of DTC 14 in the *Diagnostics* section. ***Is resistance value of ECT sensor near the resistance of the value noted?***	Step 14	Step 12
12	1. Locate and repair high resistance or poor connection in the ECT signal circuit or the ECT sensor ground. ***Is action complete?***		–
13	***Replace the ECT sensor.***		–
14	1. Check for intermittent opens or shorts to ground in the MAP sensor circuits. ***Was a problem found?***		Step 15
15	1. Check for proper operation of the TP sensor. 2. Check for throttle linkage sticking, binding or worn causing TP sensor voltage to be higher than normal. ***Is TP sensor operating improperly or is voltage higher than normal?***		Step 16
16	1. Check for proper operation of the IAC valve. (Table A-8) ***Was a problem found?***		Step 17
17	1. Check for the following engine problems: • Low compression. • Leaking cylinder head gaskets. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Restricted exhaust system. ***Was a problem found?***	OBD	Step 18
18	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system.	OBD	Contact Mercury MerCruiser Customer Service

Surges and/or Chuggles Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine power variation under steady throttle or cruise. Feels like the engine speeds up and slows down with no change in the throttle lever position.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check for contaminated fuel. 2. Check fuel filters and water separator. ***Was a problem found?***		Step 4
4	1. Check for proper fuel pressure while the condition exists. • *Refer* to Table A-4 in "General System Diagnostics" section. ***Was fuel pressure 30 psi for EFI or 3-7 psi for carbureted engines?***		Step 5
5	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check or throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. ***Was a problem found?***		Step 6
6	1. Check for proper ignition voltage output. • *Refer to* Table A-7 in "General System Diagnostics" section. ***Was a problem found?***		Step 7
7	1. Check ignition coil for cracks or carbon tracking. ***Were cracks or carbon tracks found?***		Step 8
8	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. 4. If a problem is found, repair as necessary. ***Was a problem found?***	OBD	Step 9

Surges and/or Chuggles Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Remove spark plugs and check for wet plugs. cracks, wear, improper gap, burned electrodes or heavy deposits. • *Refer to* Distributor Ignition System in "Description and System Operation" section. ***NOTE:*** *If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.* ***Were spark plugs damaged?***		Step 10
10	1. Check fuel delivery system items that can cause the engine to run rich. ***Was a problem found?***		Step 11
11	1. Check fuel delivery system items that can cause the engine to run lean. ***Was a problem found?***		Step 12
12	1. Check the injector connections for proper mating. 2. If any of the injectors connectors are connected to an incorrect cylinder, correct as necessary. ***Were any injectors improperly connected?***		Step 13
13	1. Check ECM grounds for being clean, tight and in the proper locations. ***Were ECM grounds dirty, loose or improperly connected?***		Step 14
14	1. Visually/physically check vacuum hoses for splits, kinks and proper connections and routing. ***Was a problem found?***		Step 15
15	1. Check or proper alternator voltage output. ***Is voltage between 11 - 16 volts?***		Step 16
16	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/ inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Lack of Power, Sluggish or Spongy Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine delivers less than expected power. Little or no increase in speed when throttle lever is advanced part way.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	If possible, compare engine performance with a similar engine. ***Is engine performance close to similar engine?***	No problem found	Step 3
3	***Was visual / physical check performed?***	Step 4	Visual/Physical Check
4	1. Remove and check flame arrestor for dirt, or for being restricted. 2. Clean or replace flame arrestor. ***Was flame arrestor dirty or restricted?***		Step 5
5	1. Check for contaminated fuel. 2. Check water separating fuel filter. ***Was a problem found?***		Step 6
6	1. Check for proper fuel pressure while the condition exists. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was fuel pressure 30 psi for EFI or 3-7 psi for carbureted engines?***		Step 7
7	1. Check for injector driver CKT 467 or CKT 468 for an open. ***Did you find an open?***		Step 8
8	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. ***Was a problem found?***		Step 9
9	1. Check for proper ignition voltage output. • *Refer to* Table A-7 in "General System Diagnostics" section. ***Was a problem found?***		Step 10
10	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • *Refer to* "Distributor Ignition System" in "Description and System Operation" section. ***NOTE:*** *If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.* ***Were spark plugs damaged?***	OBD	Step 11

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Lack of Power, Sluggish or Spongy Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
11	1. Check ignition coil for cracks or carbon tracking. ***Were cracks or carbon tracks found?***		Step 12
12	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check or throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. ***Was a problem found?***		Step 13
13	1. Check ECM grounds for cleanliness, tightness and proper location. ***Were ECM grounds dirty, loose or improperly connected?***	OBD	Step 14
14	1. Check diagnostic test CKT 451 for being shorted to ground. This will cause the rpm to be lowered. ***Was a problem found?***		Step 15
15	1. Check for proper alternator voltage output. ***Is voltage between 11 - 16 volts?***		Step 16
16	1. Check for the following Engine Mechanical problems: • Low compression. • Leaking cylinder head gaskets. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Restricted exhaust system. ***Was a problem found?***		Step 17
17	1. Check for excessive resistance on the bottom of the boat such as dirt, barnacles, etc. 2. Check for proper propeller size and pitch for that application. ***Was a problem found?***	OBD	Step 18
18	1. Review all diagnostic procedures within this table. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Detonation / Spark Knock Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check base timing. • *Refer to* Ignition Timing Set Procedure in the *Distributor Ignition* section. ***Was a problem found?***		Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. ***Was a problem found?***		Step 5
5	1. Check for good ignition system ground. 2. Check spark plugs for proper gap and heat range. ***Was a problem found?***		Step 6
6	1. Check for contaminated fuel. 2. Check for poor fuel quality and proper octane rating. ***Was a problem found?***		Step 7
7	1. Check for proper fuel pressure. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was fuel pressure 30 psi for EFI or 3-7 psi for carbureted engines?***	OBD	Step 8
8	***Is a scan tool being used?***	Step 9	Step 10
9	1. If scan tool readings are normal (Refer to "Scan Tool Normal Specifications" in this section) and there are no engine mechanical faults, fill fuel tank with a known high quality gasoline. ***Is detonation present?***	Step 10	OBD
10	1. Check for obvious overheating problems: • Loose water pump belt. • Faulty or incorrect water pump. • Restriction in cooling system. • Faulty or incorrect thermostat. ***Was a problem found?***	OBD	Step 11

Detonation / Spark Knock Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
11	1. Check fuel delivery system items that can cause an engine to run lean. ***Was a problem found?***		Step 12
12	1. Check for ECT sensor being shifted in value. 2. Check for proper output voltage of the TP sensor at closed throttle and wide open throttle. Also check throttle linkage for sticking, binding or worn. ***Was a problem found?***		Step 13
13	1. Check for the following Engine Mechanical problems: • Low compression. • Low oil level. • Excessive oil in the combustion chambers due to valve seals leaking. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Combustion chambers for excessive carbon build up. ***Was a problem found?***	OBD	Step 14
14	1. Remove excessive carbon buildup with a top engine cleaner. • *Refer to* instructions on top of engine cleaner can. 2. Re-evaluate engine performance. ***Is detonation still present?***	Step 15	OBD
15	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Hesitation, Sag, Stumble Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Momentary lack of response as the throttle lever is advanced. Can occur at all engine speeds. Usually most severe when first starting out. May cause engine to stall if severe enough.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check for contaminated fuel. 2. Check water separating fuel filter. ***Was a problem found?***		Step 4
4	1. Check or proper fuel pressure while the condition exists. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was a problem found?***		Step 5
5	1. Check fuel injectors. • *Refer to* Injector Balance Test in "Test General System Diagnostics" section. ***Was a problem found?***		Step 6
6	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. ***Was a problem found?***		Step 7
7	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. ***Was a problem found?***		Step 8
8	1. Remove spark plugs and check for wet plugs, cracks. wear, improper gap, burned electrodes or heavy deposits. • *Refer to* Distributor Ignition System. ***NOTE:*** *If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.* ***Were spark plugs damaged?***	OBD	Step 9

Hesitation, Sag, Stumble Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Check for the ECT sensor shifted in value. 2. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check or throttle linkage sticking, binding or worn. 3. An intermittent failure may not store a DTC. ***Was a problem found?***	OBD	Step 10
10	1. Check for proper alternator voltage output. ***Is voltage between 11 - 16 volts?***		Step 11
11	1. Check for faulty or incorrect thermostat. ***Is thermostat faulty?***		Step 12
12	1. Check intake valves for valve deposits and remove if found. ***Were deposits found on the intake valves?***		Step 13
13	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/ inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Cuts Out, Misses Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle, low speed or on hard acceleration for fuel starvation that can cause engine to cut out.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check for contaminated fuel. 2. Check water separating fuel filter. ***Was a problem found?***		Step 4
4	1. Check for proper fuel pressure while the condition exists. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was fuel pressure 30 psi for EFI or 3-7 psi for carbureted engines?***		Step 5
5	1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector. 2. Crank engine and note light on each connector. If test light fails to blink at any one of the connectors, it is a faulty injector drive circuit harness, connector or terminal. ***Was a problem found?***		Step 6
6	1. Check fuel injectors. • *Refer to* Injector Balance Test in "General System Diagnostics" section. ***Was a problem found?***		Step 7
7	1. Check for proper spark at each cylinder. ***Was a problem found?***	OBD	Step 8
8	1. Check the spark plugs for the following: • Insulator cracks. • Improper gap. • Burned electrodes. • Heavy deposits. ***NOTE:*** *If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.* ***Were spark plugs damaged?***	OBD	Step 9

Cuts Out, Misses Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Check engine mechanical for the following conditions. • Low compression. • Sticking or leaking valves. • Bent push rods • Worn rocker arms. • Broken valve springs. • Worn camshaft lobe(s). • Incorrect valve timing. ***Was a problem found?***		Step 10
10	1. Check intake and exhaust manifold(s) for casting flash. ***Was a problem found?***		Step 11
11	1. Check for Electromagnetic Interference (EMI). A missing condition can be caused by EMI on the reference circuit. EMI can usually be detected by monitoring engine rpm with a scan tool or tachometer. A sudden increase in rpm with little change in actual engine rpm change, indicates EMI is present. 2. If EMI is present, locate and repair the source. ***Was a problem found?***		Step 12
12	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Rough, Unstable or Incorrect Idle, Stalling Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine runs unevenly at idle. If severe, the engine or vessel may shake. Engine idle speed may vary in rpm. Either condition may be severe enough to stall the engine.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check for proper operation of the IAC valve. • *Refer to* Table A-8 in "General System Diagnostics" section. ***Was a problem found?***		Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. ***Was a problem found?***		Step 5
5	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. ***Was a problem found?***		Step 6
6	1. Check ignition coil for cracks or carbon tracking. ***Were cracks or carbon tracks found?***		Step 7
7	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • *Refer to* Distributor Ignition System. ***NOTE:*** *If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.* ***Were spark plugs damaged?***		Step 8
8	1. Check the injector connections. Correct as necessary. ***Was a problem found?***	OBD	Step 9

Rough, Unstable or Incorrect Idle, Stalling Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector. 2. Crank engine and note light on each connector. If test light fails to blink at any one of the connectors, it is a faulty injector drive circuit harness, connector or terminal. ***Was a problem found?***		Step 10
10	1. Check fuel injectors. • *Refer to* Injector Balance Test in "General System Diagnostics" section. ***Was a problem found?***		Step 11
11	1. Check for fuel in pressure regulator vacuum hose. 2. If fuel is present, replace the fuel pressure regulator assembly. • *Refer to* Fuel Metering System in "Description and System Operation" section. ***Was a problem found?***		Step 12
12	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check or throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. ***Was a problem found?***		Step 13
13	1. Check ECM grounds for being clean, tight and in their proper locations. 2. Also check that battery cables and ground straps are clean and secure. ***Were ECM grounds dirty, loose or improperly connected?***		Step 14
14	1. Check fuel delivery system items that can cause the engine to run rich. ***Was a problem found?***		Step 15
15	1. Check fuel delivery system items that can cause the engine to run lean. ***Was a problem found?***	OBD	Step 16

Rough, Unstable or Incorrect Idle, Stalling Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
16	1. Check or proper alternator voltage output. 2. The voltage should be between specified values. ***Is voltage between 11 - 16 volts?***		Step 17
17	1. Check the following Engine Mechanical items: • Check compression. • Sticking or leaking valves. • Worn camshaft lobe(s). • Valve timing. • Broken valve springs. ***Was a problem found?***		Step 18
18	1. Check intake valves for valve deposits. 2. If deposits are found, remove as necessary. ***Were deposits found on the intake valves?***		Step 19
19	1. Check for faulty motor mounts. ***Was a problem found?***		Step 20
20	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Poor Fuel Economy Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Fuel economy is noticeably lower than expected. Also, economy is noticeably lower than it was on this engine at one time.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check operators driving habits. Are excessively heavy loads being carried? Is operator accelerating too much, too often? ***Was a problem found?***	System normal	Step 4
4	1. Check flame arrestor for dirt or being plugged. 2. Check for fuel leaks. ***Was a problem found?***		Step 5
5	1. Check for proper fuel pressure. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was fuel pressure 30 psi for EFI or 3-7 psi for carbureted engines?***		Step 6
6	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. ***Was a problem found?***		Step 7
7	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • *Refer to* Distributor Ignition System. ***NOTE:*** *If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs.* ***Were spark plugs damaged?***		Step 8
8	1. Visual (physically) check vacuum hoses for splits, kinks and improper connections and routing. ***Was a repair required?***		Step 9
9	1. Check engine compression for being low. ***Was a problem found?***	OBD	Step 10

Poor Fuel Economy Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
10	1. Check exhaust system for possible restriction. 2. Inspect exhaust system for damaged or collapsed pipes. ***Was a problem found?***	OBD	Step 11
11	1. Check for excessive resistance on the bottom of the boat such as dirt, barnacles, etc. 2. Check for proper propeller size and pitch for that application. ***Was a problem found?***	OBD	Step 12
12	1. Review all diagnostic procedures within this table. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Dieseling, Run-On Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine continues to run after key is turned "OFF," but runs very rough. If engine runs smooth, check ignition switch and adjustment.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check for leaking fuel injectors. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was a problem found?***	OBD	Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. ***Was a problem found?***	OBD	Step 5
5	1. Check for obvious overheating problems: • Loose water pump belt. • Faulty or incorrect water pump. • Restriction in cooling system. • Faulty or incorrect thermostat. ***Was a problem found?***	OBD	Step 6
6	1. Check for proper operation of the EFI system relay. • *Refer to* Table A-6 in "General System Diagnostics" section. ***Was a problem found?***	OBD	Step 7
7	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

Backfire Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Fuel ignites in the intake manifold, or in the exhaust system, making loud popping noise.			
1	***Was the "On-Board Diagnostic" (OBD) System Check performed?***	Step 2	OBD
2	***Was visual/physical check performed?***	Step 3	Visual/Physical Check
3	1. Check flame arrestor for proper installation. ***Was a problem found?***		Step 4
4	1. Check for proper fuel pressure. • *Refer to* Table A-4 in "General System Diagnostics" section. ***Was fuel pressure 30 psi for EFI or 3-7 psi for carbureted engines?***		Step 5
5	1. Check the injector connections. Correct as necessary. ***Was a problem found?***		Step 6
6	1. Check fuel injectors. • *Refer to* Injector Balance Test in "General System Diagnostics" section. ***Was a problem found?***		Step 7
7	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. ***Was a problem found?***		Step 8
8	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. ***Was a problem found?***		Step 9
9	1. Check ignition coil for cracks or carbon tracking. ***Were cracks or carbon tracks found?***	OBD	Step 10

Backfire Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
10	1. Check for proper ignition voltage input to the ECM. 2. Check for intermittent open or short to ground on the ignition voltage input circuit to the ECM. ***Was a problem found?***		Step 11
11	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • *Refer to* Distributor Ignition System in "Description and System Operation" section. ***NOTE:*** *If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs* ***Were spark plugs damaged?***		Step 12
12	1. Check for intermittent opens or short to grounds in the MAP sensor and TP sensor circuits. Also check for throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. ***Was a problem found?***		Step 13
13	1. Check engine mechanical for the following conditions: • Low compression. • Sticking or leaking valves. • Worn camshaft lobe(s). • Incorrect valve timing. ***Was a problem found?***		Step 14
14	1. Check intake and exhaust manifold(s) for casting flash. ***Was a problem found?***		Step 15
15	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. ***Was a problem found?***	OBD	Contact Mercury MerCruiser Customer Service

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FUEL SYSTEMS

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5I

Special Tools

Part Number	Tool Name	Description
J-34029-A (***Note 1*** and ***2***)	High Impedance Multimeter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ.
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator.
J-34142-B (***Note 3***)	Unpowered Test Light	Used to check circuit wiring, short to ground or voltage.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
94050m	MerCruiser Scan Tool Version 3.4 (English)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors. Tool can read MEFI 1 and MEFI 3 ECM.
94008	Code Mate Tester	Flashes light to display problem codes.
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A5	Fuel Pressure Gauge Kit	Used to check fuel system pressure. Kit includes 91-803135 Test Port Adaptor Kit and 91-806901 TBI Pressure Valve.
91-823686A2	Quicksilver Digital Diagnostic Terminal (DDT)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-803999	MerCruiser DDT Cartridge Version 2	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Tool can read MEFI 1 and MEFI 3 ECM.
84-822560A2	DDT Adaptor Harness	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-805747A2	EFI Timing Tool	Used to set Ignition timing. Plug connects to DLC.
91-805918A2	Fuel Shutoff Tool	Used to perform fuel system pressure test.
91-806901	Fuel Line Connector	Allows connection of Fuel Pressure Gauge.

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Special Tools (continued)

NOTE: [1] *The High Impedance Multimeter that comes with the existing Outboard 2 Cycle EFI Tester, P/N 91-11001A2 meets the requirements listed above.*

NOTE: [2] *Quicksilver Digital Tachometer / Multi–Meter (DMT 2000) P/N 91-854009A1, meets the requirements listed above.*

NOTE: [3] *Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 773-736-6633
Fax: 773–736–2950
E–mail: rinda@mcs.net

Diagnostic Circuit Check

IMPORTANT: All references to Scan Tool work with either the Quicksilver Digital Diagnostic Tool or the Rinda Scan Tool.

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

NOTE: *A scan tool that displays faulty data should not be used. This could result in misdiagnosis and unnecessary parts replacement.*

The scan tool data listed in the following table may be used for comparison after finding the on-board diagnostics functioning properly and no trouble codes displayed. The “Typical Data Values” are intended to represent what a normally functioning system would display.

Only the parameters listed in the scan position column below are used in this manual. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to “Troubleshooting.”

Scan Tool Normal Specifications (Idle/Warm Engine/Closed Throttle/Neutral)

Scan Position	Units Displayed	Typical Data Value
rpm	rpm	600-700 rpm
Desired rpm	rpm	600 or 650 rpm (Depends on Model[2])
Coolant Temp.	° F(° C)	150-170° F (66-77° C)
Manifold Air Temp.	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5–3.5 msec. (Depends on Water/ Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH(3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration Check Sum	Varies with Software revision in ECM
Oil Press/IO Level[1]	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Lanyard Stop Mode	OFF/ON	OFF

[1]: MCM will read I/O Level and MIE will read Trans.

[2] : Refer to “Engine and Tune-Up Specifications.”

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Diagnostic Trouble Codes

Code Number	Code Description	MEFI	
		1	3
Code 14	(ECT) Engine Coolant Temperature - Low Temperature Indicated	x	x
Code 15	(ECT) Engine Coolant Temperature - High Temperature Indicated		x
Code 21	(TP) Throttle Position Sensor - Signal Voltage High	x	x
Code 22	(TP) Throttle Position Sensor - Signal Voltage Low		x
Code 23	(MAT) Manifold Air Temperature - Low Temperature Indicated		x
Code 25	(MAT) Manifold Air Temperature - High Temperature Indicated		x
Code 33	(MAP) Manifold Absolute Pressure - Signal Voltage High	x	x
Code 34	(MAP) Manifold Absolute Pressure - Signal Voltage Low		x
Code 41	(IC) Ignition Control - Open IC Circuit		x
Code 42	(IC) Ignition Control - Grounded IC Circuit, Open or Grounded Bypass	x	x
Code 43	(KS) Knock Sensor - Continuous Knock Detected	x	x
Code 44	(KS) Knock Sensor - No Knock Detected		x
Code 45	Coil Driver		x
Code 51	(ECM) Calibration Memory Failure	x	x
Code 61	Fuel Pressure High		x
Code 62	Fuel Pressure Low		x

ECM Connector and EFI Symptoms Chart

The following charts will aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system intact and operational. These are voltage requirements to operate the different circuits.

⚠ CAUTION

Do not attempt to obtain these voltages by probing wires and connectors. Serious damage could result in loss of engine operation or wiring damage. Voltages can vary with battery conditions.

In the following J-1 and J-2 Circuit/Symptom Charts only those pins which are used by the ECM are shown. Pin numbers not listed are not used.

NOTE: *All pins are not used on all models.*

IMPORTANT: The following conditions must be met before testing.

1. Engine at operating temperature.
2. Ignition on or engine running.
3. Scan tool not connected.

THESE NOTES APPLY TO FOLLOWING ECM CONNECTOR AND SYMPTOM CHARTS. The “B+” Symbol indicates a system voltage (battery).

NOTE: [1] *Battery voltage for first two seconds, then 0 volts.*

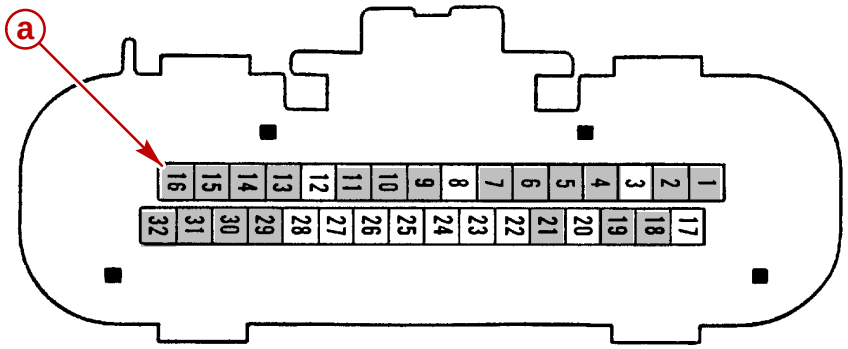
NOTE: [2] *Varies with temperature.*

NOTE: [3] *Varies with manifold vacuum.*

NOTE: [4] *Varies with throttle movement.*

NOTE: [5] *Less than .5 volt (500 mV).*

J-1 Circuits with MEFI 1



J-1 Front Pin 32 Pin Input Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

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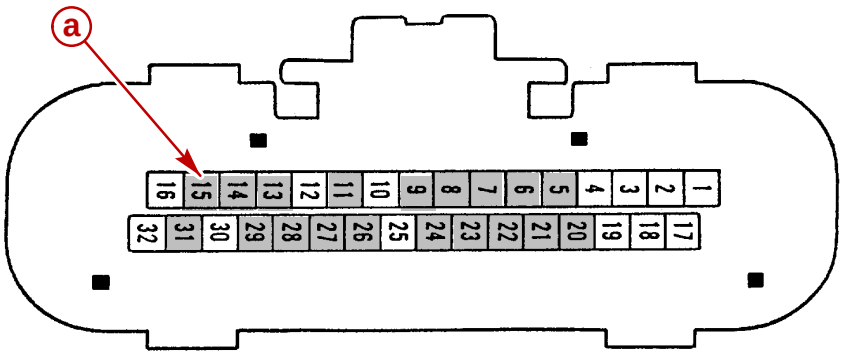
J-1 Circuits with MEFI 1 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Knock Sensor	485	GRN	9.5V	9.5V	43	Poor Fuel Economy, Poor Performance Detonation
J1-2	ECT Signal	410	YEL	1.95V *(NOTE 2)*	1.95V *(NOTE 2)*	14	Poor Performance, Exhaust Odor, Rough Idle rpm Reduction
J1-4	Discrete Switch	931	BRN	–	–	None	Power Reduction Mode Alarm Activation
J1-5	Master/ Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J1-6	Discrete Switch	931	BRN	–	–	None	Power Reduction Mode Alarm Activation
J1-7	Diag-nostic Test	451	BLK/ WHT	B+	B+	None	Incorrect Idle, Poor Performance
J1-9	Map Signal	432	LT GRN	4.9V	1.46V *(NOTE 3)*	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J1-10	TP Signal	417	DK BLU	.62V *(NOTE 4)*	.62V *(NOTE 4)*	21	Poor Performance And Acceleration, Incorrect Idle
J1-11	Ignition Fused	439	PNK/ BLK	B+	B+	None	No Start
J1-13	Sensor Ground	813	BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	21,23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J1-14	ECM Ground	450	BLK/ WHT	0 *(NOTE 5)*	0 *(NOTE 5)*	None	No Start
J1-15	TP 5V Power	416	GRY	5V	5V	21	Lack Of Power, Idle High
J1-16	Battery	440	ORN	B+	B+	None	No Start
J1-18	Serial Data	461	ORN/ BLK	5V	5V	None	No Serial Data
J1-19	Shift Switch	923	WHT	0	0	None	Incorrect Idle
J1-21	Lanyard Stop	942	PNK	0	0	None	No Start
J1-29	MAP Ground	814	BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	33	Lack Of Performance,Exhaust Odor, Stall
J1-30	ECM Ground	450	BLK/ WHT	0 *(NOTE 5)*	0 *(NOTE 5)*	None	No Start
J1-31	MAP 5V Power	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J1-32	Battery	440	ORN	B+	B+	None	No Start

J-2 Circuits with MEFI 1



J-2 Rear 32 Pin Output Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-5	Injector Driver	468	LT GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J2-6	Ignition Control Ref. Low	463	RED/ BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	None	Poor Performance
J2-7	Not Used	–	–	–	–	None	Not Used
J2-8	Ignition Control Ref. High	430	PUR/ WHT	5V	1.6V	None	No Restart
J2-9	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 *(NOTE 1&5)*	B+	None	No Start
J2-11	Coolant Over temp.	112	DK GRN	0	0	None	Power Reduction Mode or Improper Audio Warning
J2-13	IAC “A” Low	442	RED	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-14	IAC “B” Low	443	YEL	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-15	Injector Ground	450	BLK/ WHT	0 *(NOTE 5)*	0 *(NOTE 5)*	None	Rough Running, Lack Of Power, Poor Performance

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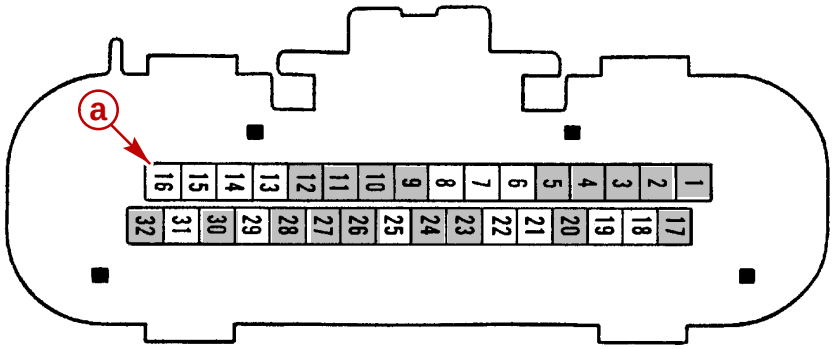
J-2 Circuits with MEFI 1 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-20	Fuel Injector Ground	450	BLK/ WHT	0 *(NOTE 5)*	0 *(NOTE 5)*	None	Rough Running, Poor Idle, Lack Of Performance
J2-21	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J2-22	Not Used	–	–	–	–	–	Not Used
J2-23	Ignition Control Signal	423	WHT	0 *(NOTE 5)*	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J2-24	Ignition Control Bypass	424	TAN/ BLK	0 *(NOTE 5)*	4.5V	42	Lack Of Power, Fixed Timing
J2-26	Discrete Switch	31	TAN	–	–	–	Audio Warning System Activation
J2-27	Discrete Switch	31	TAN	–	–	–	Audio Warning System Activation
J2-28	IAC “A” High	441	BRN	Not Usable	Not Usable	None	Rough, Unstable or Incorrect Idle
J2-29	IAC “B” Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough, Unstable or Incorrect Idle
J2-31	MIL Lamp	419	BRN/ WHT	0 *(NOTE 5)*	0 *(NOTE 5)*	None	Lamp Inoperative

J-1 Circuits with MEFI 3



J-1 Front Pin 32 Pin Input Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J1-2	Ignition Coil	121	WHT	Not Usable	Not Usable	45	Rough Running, Poor Idle, Lack of Performance
J1-3	Ignition Control Ref. Low	453	RED/ BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	None	Poor Performance
J1-4	ECM Ground	450	BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	None	No Start
J1-5	ECM Ground	450	BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	None	No Start
J1-9	MIL Lamp	419	BRN/ WHT	0 *(NOTE 5)*	0 *(NOTE 5)*	None	Lamp Inoperative
J1-10	Ignition Control Signal	423	WHT	0 *(NOTE 5)*	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J1-11	IAC “B” Low	443	GRN/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-12	IAC “A” Low	442	BLU/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-17	Injector Driver	468	DK GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J1-20	ECM Ground	450	BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	None	Rough Running, Poor Idle, Lack Of Performance

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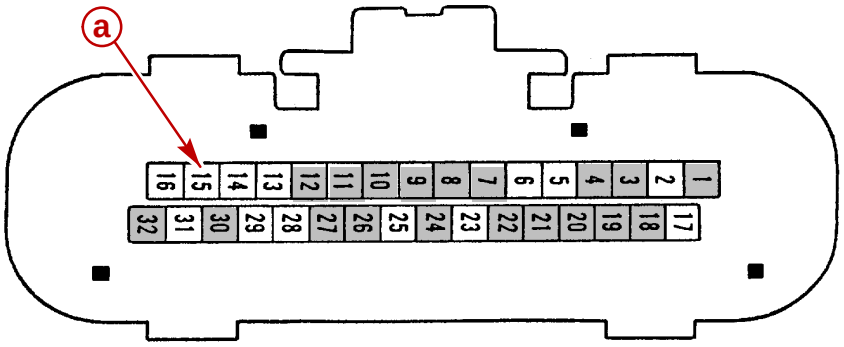
J-1 Circuits with MEFI 3 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-23	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 ***(NOTES 1&5)***	B+	None	No Start
J1-24	Ignition Control Bypass	424	TAN/ BLK	0 ***(NOTE 5)***	4.5V	42	Lack Of Power, Fixed Timing
J1-26	Audio Warning Horn	29	DK GRN	–	–	None	–
J1-27	IAC “B” Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-28	IAC “A” High	441	BLU/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-30	Knock Sensor Signal	496	BLU	–	–	43, 44	Poor Fuel Economy, Poor Performance Detonation
J1-32	Serial Data	461	ORN	5V	5V	None	No Serial Data

J-2 Circuits with MEFI 3



J-2 Rear 32 Pin Output Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-1	Battery	440	ORN	B+	B+	None	No Start
J2-3	Sensor Ground	813	BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	21,23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J2-4	TP 5V Power	416	GRY	5V	5V	21	Lack Of Power, Idle High
J2-7	Discrete Switch	114	BLU	–	–	None	–
J2-8	Discrete Switch	585	TAN/ WHT	–	–	None	–
J2-9	Shift Switch	923	WHT	0	0	None	Incorrect Idle
J2-10	Ignition Control Ref. High	430	PUR/ WHT	5V	1.6V	None	No Restart
J2-11	ECT Signal	410	YEL	1.95V *(NOTE 2)*	1.95V *(NOTE 2)*	14	Poor Performance, Exhaust Odor, Rough Idle rpm Reduction
J2-12	Fuel Pressure	475	GRN	3V	3V	61, 62	–
J2-18	MAP Ground	814	BLK	0 *(NOTE 5)*	0 *(NOTE 5)*	33	Lack Of Performance,Exhaust Odor, Stall
J2-19	MAP 5V Reference	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J2-20	Discrete Switch	208	BRN	–	–	–	–

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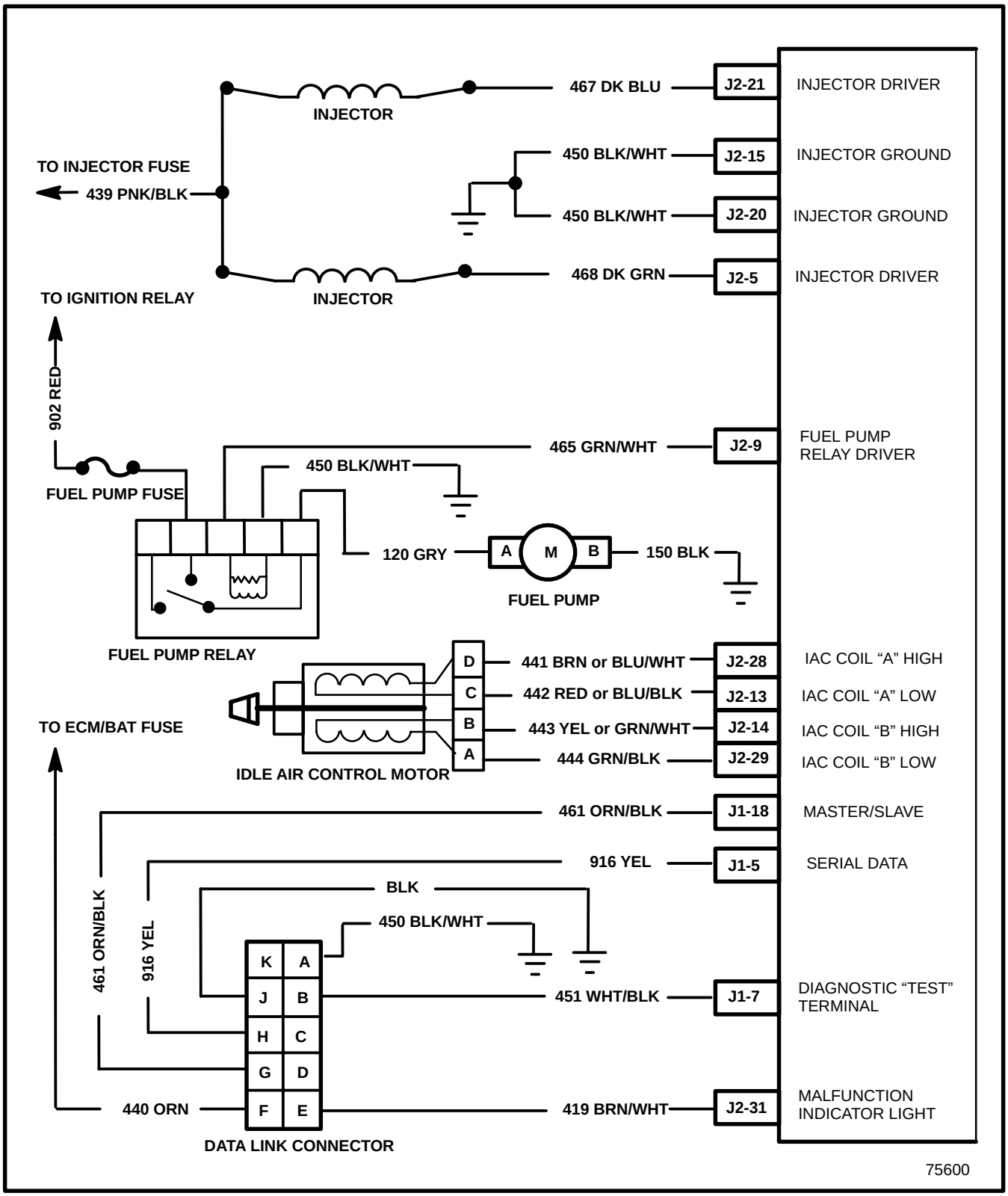
J-2 Circuits with MEFI 3 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-21	Master/ Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J2-22	Diagnostic Test	451	BLK/ WHT	B+	B+	None	Incorrect Idle, Poor Performance
J2-24	Discrete Switch	906	TAN/ WHT	–	–	None	
J2-26	TP Signal	417	DK BLU	.62V ***(NOTE 4)***	.62V ***(NOTE 4)***	21	Poor Performance And Acceleration, Incorrect Idle
J2-27	Map Signal	432	LT GRN	4.9V	1.46V ***(NOTE 3)***	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J2-30	IAT Sensor	472	TAN	5V	***(NOTE 2)***	23	Poor Fuel Economy, Exhaust Odor
J2-32	Ignition Fused	439	PNK	B+	B+	None	No Start

Wiring System Diagrams

MEFI 1



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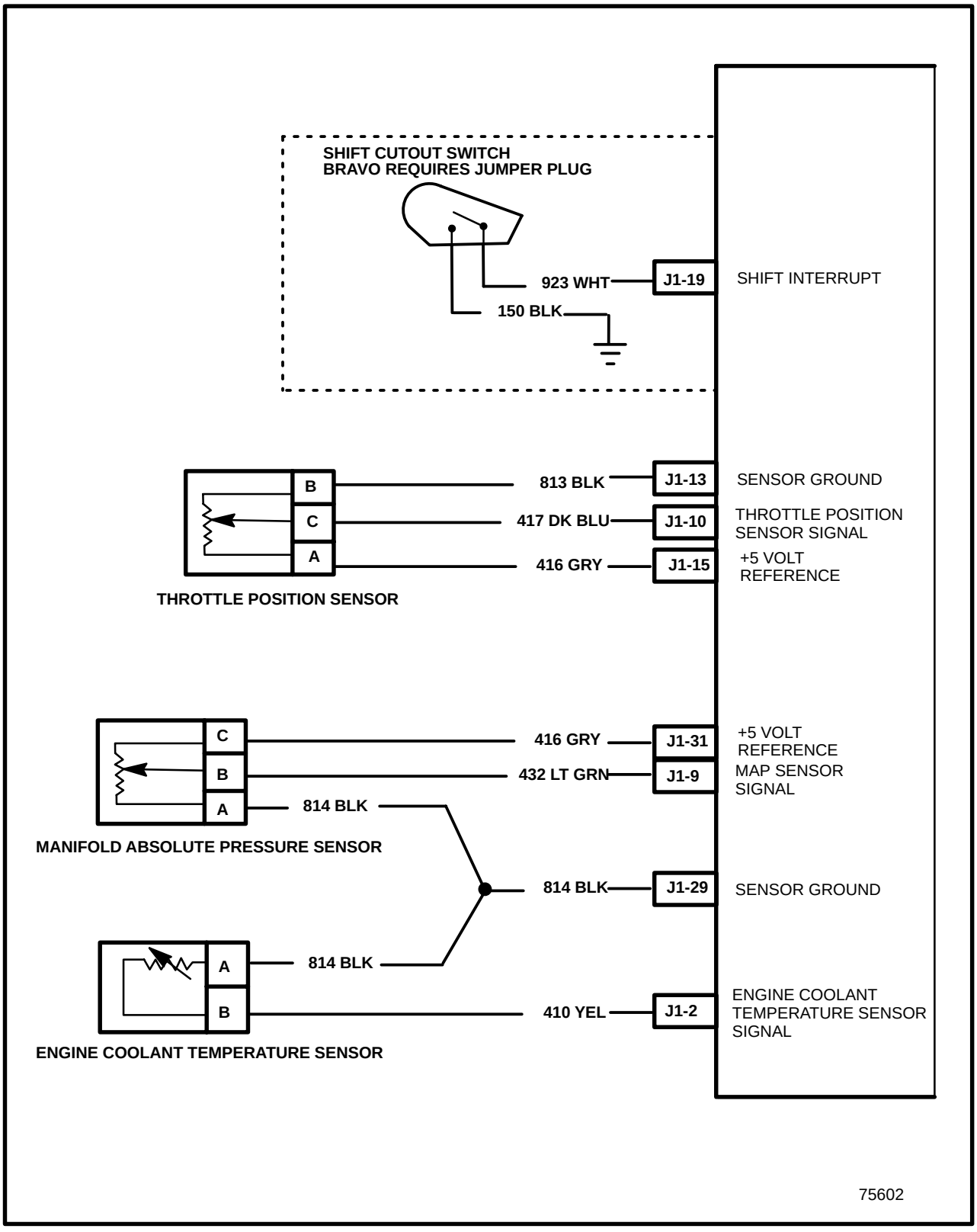

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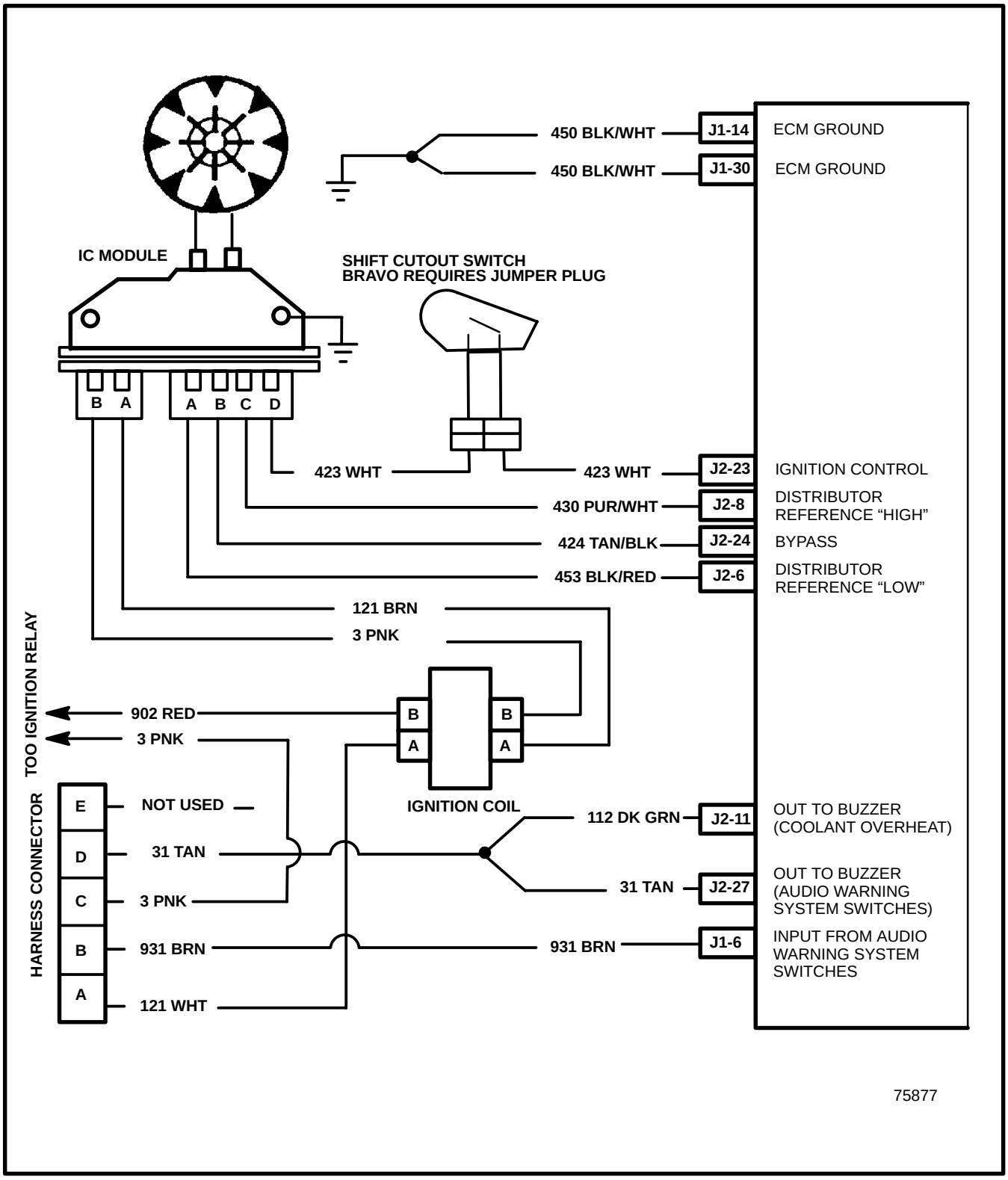

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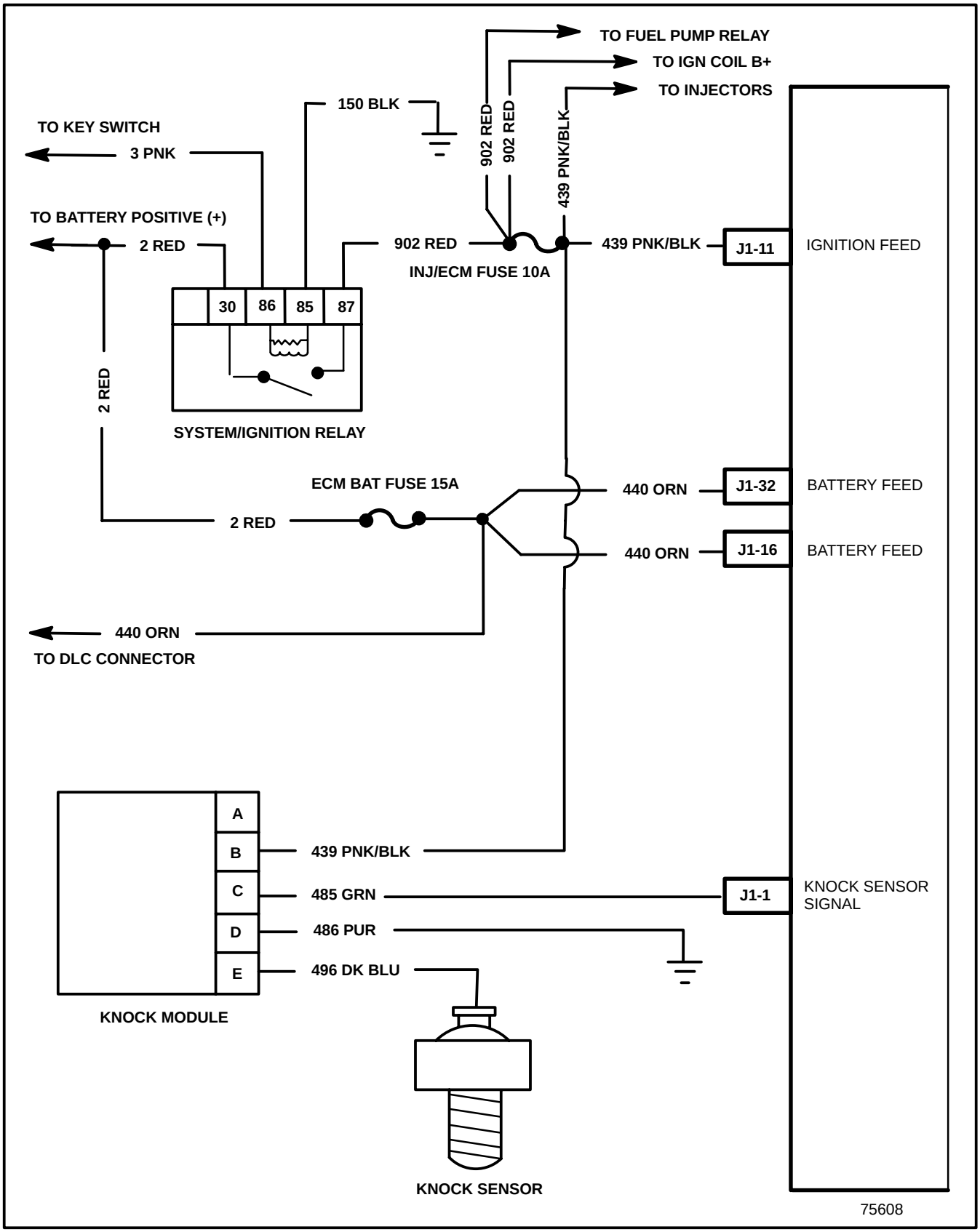
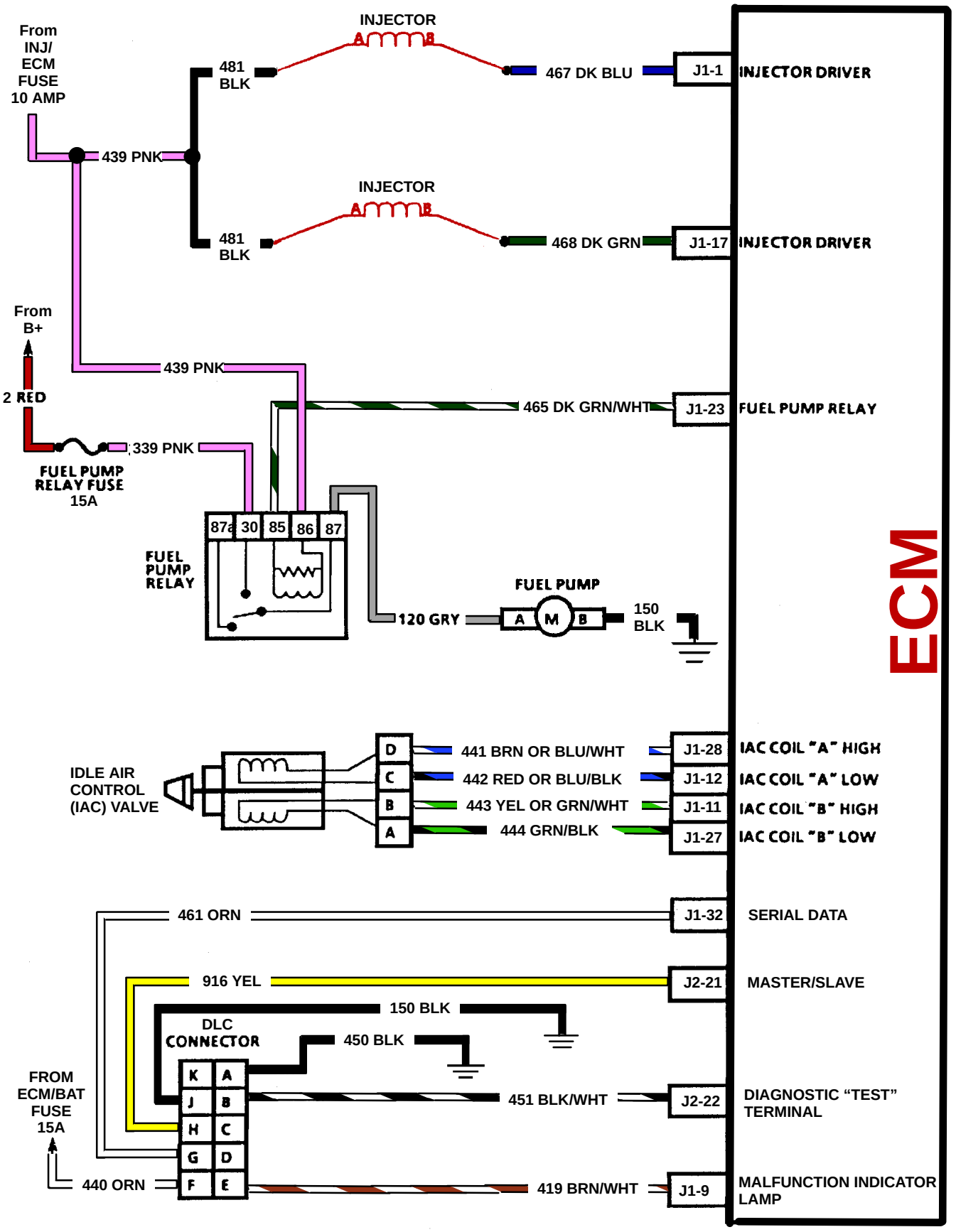


MEFI 3



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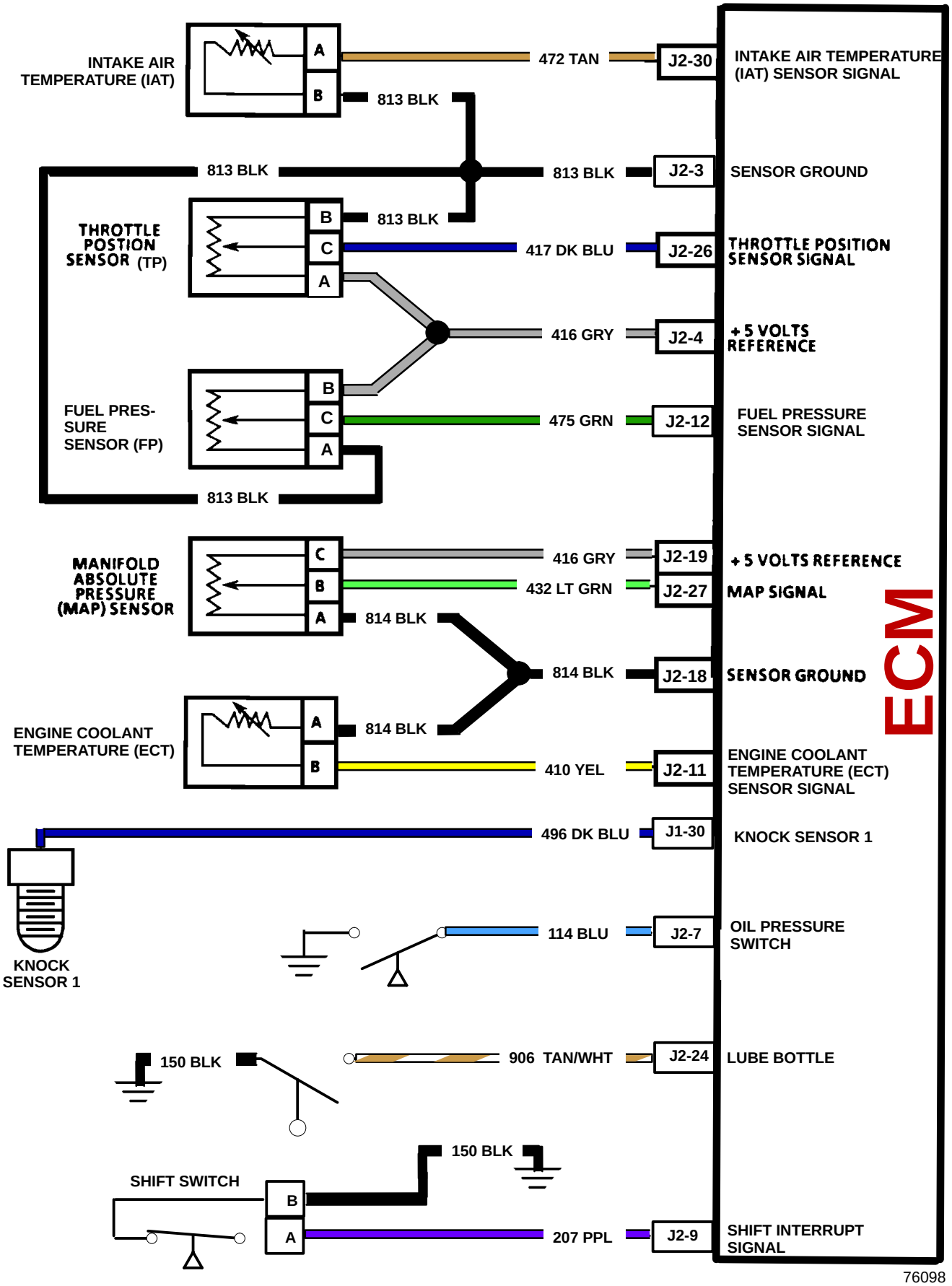
MEFI 3 (Continued)



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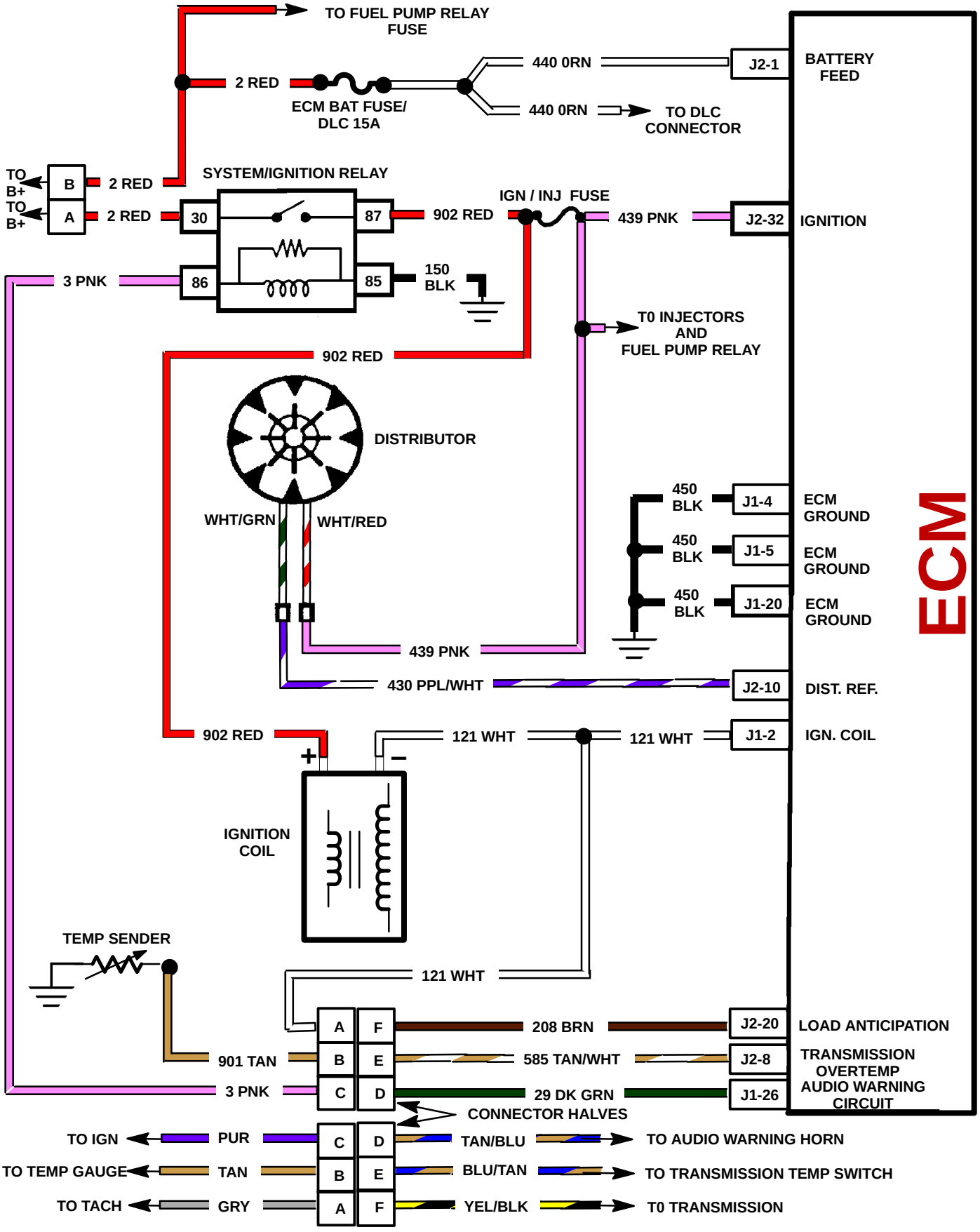
MEFI 3 With Mercury Distributor



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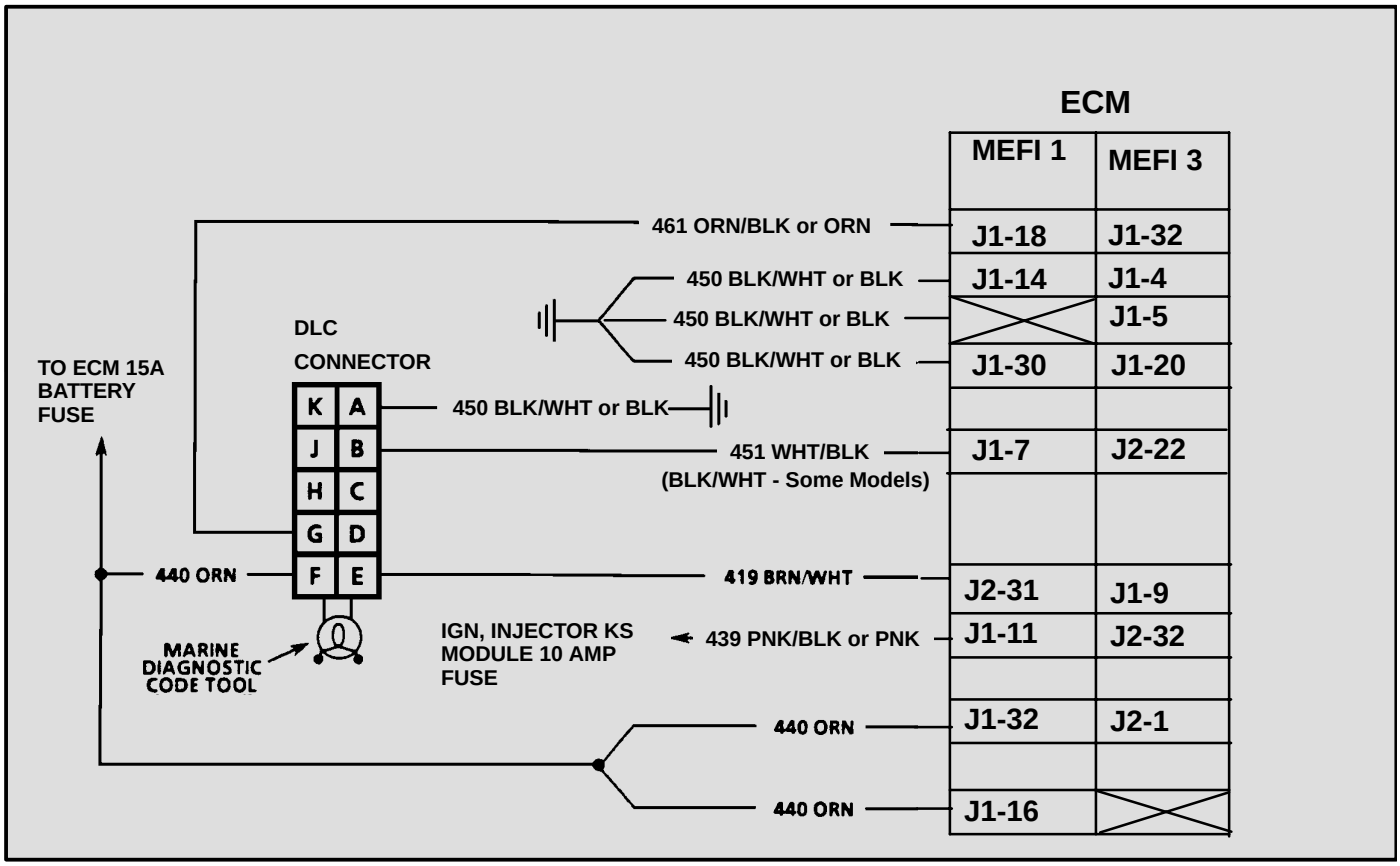
General Diagnostic Tests

On-Board Diagnostic (OBD) System Check



CIRCUIT DESCRIPTION:

The on-board diagnostic system check must be the starting point for any diagnosis. Before using this procedure, check the ECM and engine grounds for cleanliness and tightness.

The on-board diagnostic system check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

On-Board Diagnostic (OBD) System Check

Step	Action	Yes	No
		PROCEED TO	
1.	***Are you using a Scan Tool?***	Step 2.	Step 6.
2.	a. Ignition OFF. b. Install a scan tool. c. Ignition ON. d. Attempt to display ECM data with the scan tool. ***Does The Scan Tool Display ECM Data?***	Step 3.	Chart A-1
3.	Attempt to start the engine. ***Did The Engine Start And Continue To Run?***	Step 4.	Chart A-3
4.	Select “Display DTCs” with the scan tool. ***Are Any Trouble Codes Stored?***	DTC Chart	Step 5.
5.	Compare ECM data values displayed on the scan tool to the typical scan tool data values page. ***Are The Displayed Values Normal Or Close To The Typical Values?***	Trouble-shooting	Diag-nostic Testing
6.	a. Ignition ON, engine OFF. b. Install CodeMate Tester and switch it to “Normal Mode.” c. Observe the MIL. ***Is the MIL ON?***	Step 7.	Chart A-1
7.	a. With CodeMate Tester on “Normal Mode.” b. Ignition ON, engine OFF. c. Observe the MIL on the CodeMate Tester. ***Does the MIL Flash DTC 12?***	Step 12.	Step 8.
8.	a. Switch CodeMate Tester to “Service Mode.” b. Ignition ON, engine OFF. c. Observe the MIL on the CodeMate Tester. ***Does the MIL Flash DTC 12?***	Step 9.	Chart A-2
9.	a. Switch CodeMate Tester to “Normal Mode.” b. Attempt to start the engine. ***Did The Engine Start And Continue To Run?***	Step 10.	Chart A-3
10.	a. Ignition ON, Engine OFF. b. Switch CodeMate Tester to “Service Mode.” ***Are Any Additional DTC Stored?***	DTC Chart	Step 11.
11.	***Does A Customer Complaint Or Driveability Problem Currently Exist?***	Symp-toms	Diag-nostic Aids
12.	Check CKT 451 for a short to ground.	Verify Repair	–

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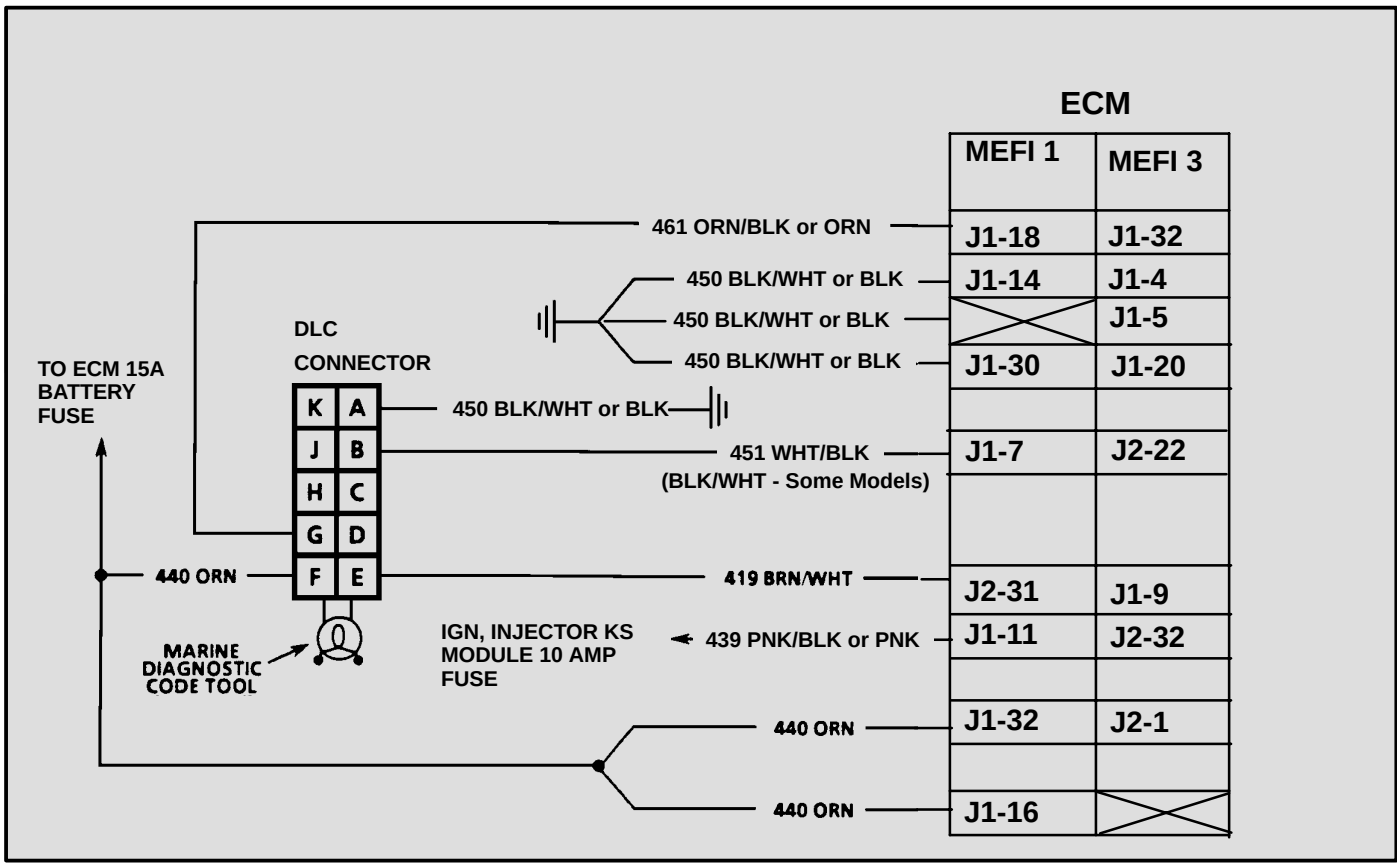
Chart A-1 (1 of 2): No MIL or No DLC Data



CIRCUIT DESCRIPTION:

When the CodeMate Tester is installed, it plugs into the DLC terminals “F” and “E.” It receives voltage through CKT 440 terminal “F.” Terminal “E” is ground through CKT 419. There should always be a steady MIL with the ignition ON and the engine stopped. The Engine Control Module (ECM) turns the MIL on by grounding the MIL driver circuit.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

If the engine runs OK, check for a faulty light bulb or an open in the MIL driver circuit (CKT 419). If the engine cranks but will not run, check for an open ECM ignition or battery feed or a poor ECM to engine ground.

Chart A-1 (2 of 2): No MIL or No DLC Data

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Remove CodeMate Tester or Scan Tool. b. Ignition ON, engine OFF. c. Using a test light connected to ground (–), probe terminal "F" of the DLC. ***Does The Test Light Illuminate?***	Step 3.	Step 10.
3.	Using a test light connected to battery positive (B+), probe terminal "E" of the DLC. ***Does The Test Light Illuminate?***	Step 11.	Step 4.
4.	a. Ignition OFF. b. Disconnect ECM connectors. c. Using a DVOM, measure the resistance between ECM CKT 419 and DLC terminal "E." ***Is The Resistance Less Than 1 ohm?***	Step 5.	Step 13.
5.	Are you using a Scan Tool?	Step 6.	Step 11.
6.	Check the ECM / DLC fuse. ***Is The Fuse Good?***	Step 7.	Step 14.
7.	a. Ignition OFF. b. Disconnect the ECM connectors. c. Using a test light connected to ground, probe ECM CKT 440. ***Does The Test Light Illuminate?***	Step 8.	Step 10.
8.	a. Ignition ON, engine 0FF. b. Using a test light connected to ground (–), probe ECM CKT 439. ***Does The Test Light Illuminate?***	Step 12.	Step 9.
9.	Check the Ignition / Injection fuse. ***Is The Fuse Good?***	Chart A-6	Step 15.
10.	Locate and repair open or short to ground in CKT 440.	Verify Repair	–
11.	Repair or replace faulty CodeMate Tester.		
12.	If problem was no DLC data (using scan tool), check serial data CKT 461 for an open or short to ground or locate and repair faulty ECM grounds.		
13.	Locate and repair open in CKT 419.		
14.	Locate and repair short to ground in the battery feed circuit.		
15.	Locate and repair short to ground in CKT 439.		

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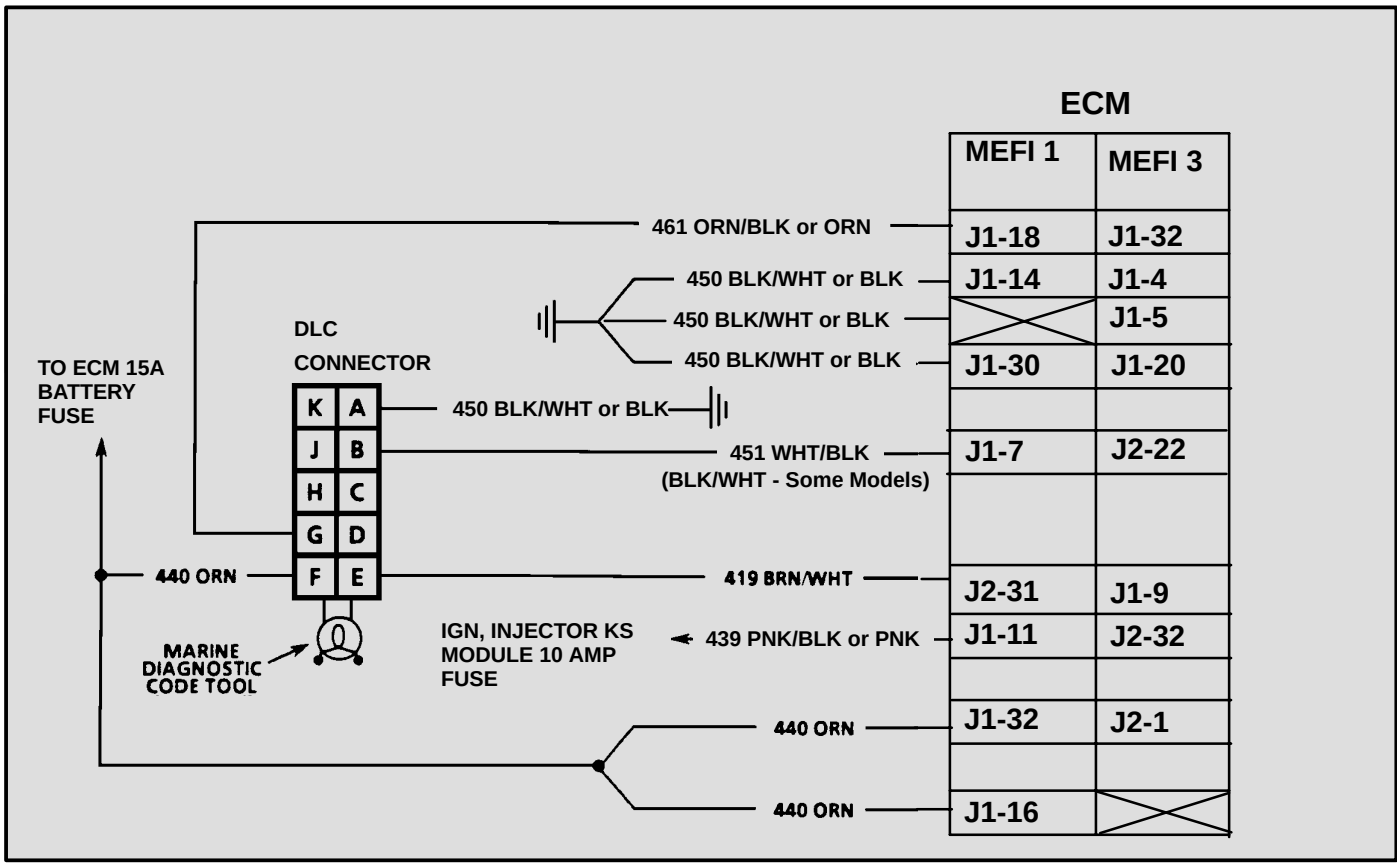
Chart A-2 (1 of 2): MIL ON Steady - Will Not Flash DTC 12



CIRCUIT DESCRIPTION:

When the CodeMate Tester is installed, it plugs into the DLC terminals “F” and “E.” It receives voltage through CKT 440 terminal “F.” Terminal “E” is ground through CKT 419 from the ECM. There should always be a steady MIL with the ignition ON and the engine stopped. The Engine Control Module (ECM) turns the MIL ON by grounding the MIL driver circuit.

When the diagnostic tests terminal on the DLC is grounded by jumping terminal “B” to terminal “A,” the ground circuit is completed. The MIL will flash a DTC 12 followed by any DTC stored in memory. A steady light suggests CKT 419 is shorted to ground or an open in CKT 451 from the ECM to the DLC.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

If the engine runs OK, check for a faulty light bulb or an open in the MIL driver circuit (CKT 419). If the engine cranks but will not run, check for an open ECM ignition or battery feed or a poor ECM to engine ground.

Chart A-2 (2 of 2): MIL ON Steady - Will Not Flash DTC 12

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Ignition ON, engine OFF. b. Switch CodeMate Tester to "Normal Mode." ***Does The MIL Flash DTC 12?***	Step 9.	Step 3.
3.	a. Ignition ON, engine OFF. b. Switch CodeMate Tester to "Service Mode." ***Does The MIL Flash DTC 12?***	Step 10.	Step 4.
4.	a. Ignition OFF, disconnect ECM connectors. b. Ignition ON, engine OFF, observe the MIL. ***Is The MIL ON?***	Step 7.	Step 5.
5.	a. Ignition OFF. b. With ECM connectors disconnected, jump terminals "A" to "B" at the DLC. c. Connect test light between CKT 451 and battery positive (B+). ***Does Test Light Illuminate?***	Step 6.	Step 8.
6.	Verify correct operation of CodeMate Tester on a known good system.	Verify Repair	–
7.	Locate and repair short to ground in CKT 419.		
8.	Locate and repair open in CKT 450 and/or CKT 451.		
9.	Check CKT 451 for short to ground.		
10.	Locate and repair intermittent faulty connections.		

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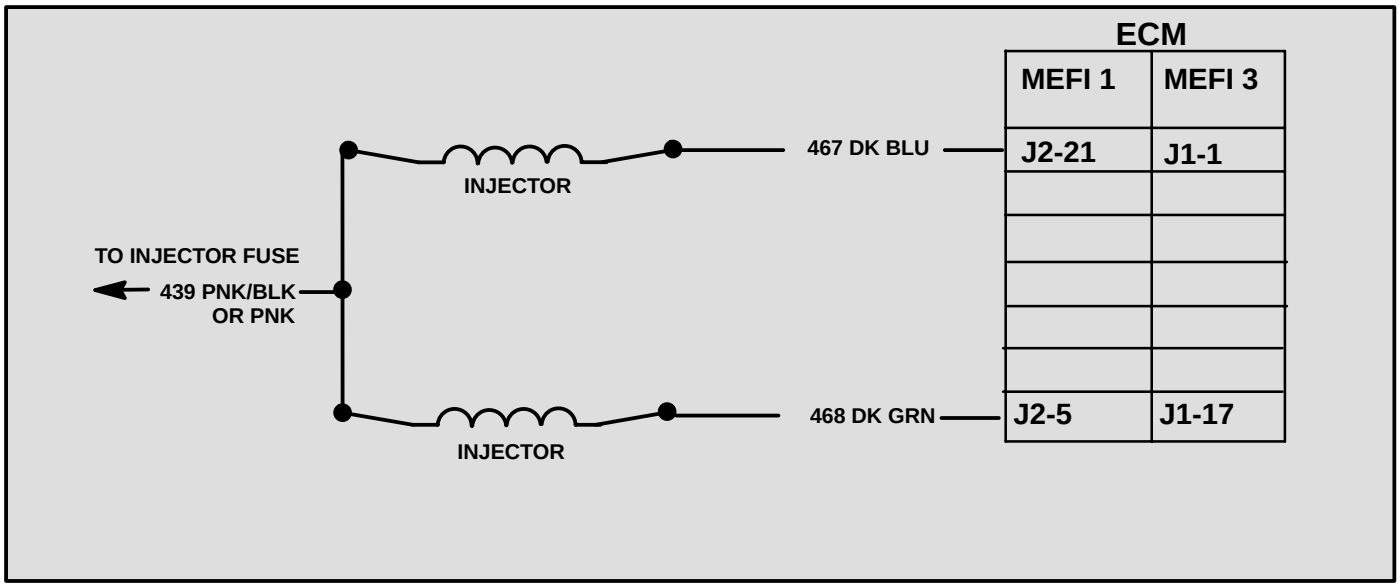
Chart A-3 (1 of 2): Engine Cranks But Will Not Run



CIRCUIT DESCRIPTION:

In the Distributor Ignition (DI) system and the fuel injector circuit, the supply voltage comes from the EFI system relay. From the EFI system relay, CKT 902 delivers supply voltage to the injector/ECM fuse, and to the ignition coil.

After supply voltage passes through the injector/ECM fuse, it branches out into two separate CKTs 439. The ECM will control the opening and closing of the injectors through injector driver CKT 467 and CKT 468 by connecting them to ground.

DIAGNOSTIC AIDS:

This chart assumes that battery voltage and engine cranking speed are OK, and there is adequate fuel in the tank.

Water or foreign material in fuel system can cause a no start.

A defective MAP sensor may cause a no start or a start and stall condition. To determine if the MAP sensor is causing the problem, disconnect the electrical connector. The ECM will then use a default value for the sensor. If the condition is corrected and the connections are OK, then replace the sensor.

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.

If above are all OK, refer to “Hard Start” in “Troubleshooting” section.

Chart A-3 (2 of 2): Engine Cranks But Will Not Run

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Key OFF for minimum of 10 seconds. b. Key ON. c. Listen for fuel pump to run. ***Does Fuel Pump Run For 2 Seconds?***	Step 3.	Chart A-5
3.	Check for secondary ignition spark. ***Is Adequate Spark Present?***	Step 4.	Chart A-7
4.	a. Install fuel pressure gauge. b. Ignition OFF for 10 seconds. c. Ignition ON. Fuel pump will run for about 2 seconds. d. Note fuel pressure with pump running. The pressure may drop after the pump stops running. ***Is Fuel Pressure Greater Than 25 psi (172 kPa)?***	Step 5.	Chart A-4
5.	a. Ignition OFF. b. Disconnect ECM connectors. c. Measure resistance between ECM CKT 467 and ECM CKT 468. ***Is The Resistance Greater Than 1 ohm?***	Step 6.	Step 10.
6.	Check resistance across each injector in the circuit. ***TBI: Is Resistance Greater Than 1 ohm?***	Step 7.	Step 8.
7.	a. Reconnect injectors. b. Ignition OFF. c. Disconnect ECM. d. Ignition ON. e. Using a test light connected to ground, probe ECM CKT 467 and CKT 468. ***Does Test Light Illuminate?***	Step 11.	Step 9.
8.	Locate and repair short to ground or replace any injector that measures low.	Verify Repair	–
9.	Locate and repair open in CKT 467 or CKT 468.		
10.	Check for short to ground in CKT 467 or CKT 468.		
11.	a. Disconnect all injectors. b. Ignition ON. c. Using a test light connected to ground, probe CKT 467 and CKT 468 on the ECM side of the injector harness (Test one injector harness on each side of the engine). If light is ON, locate and repair short to voltage.		

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Chart A-4 (1 of 2): Fuel System Diagnosis

CIRCUIT DESCRIPTION:

When the ignition is turned ON, the Engine Control Module (ECM) will turn the fuel pump ON for 2 seconds. During engine cranking, the ECM will turn ON the fuel pump. It will remain ON as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses. If there are no reference pulses, the ECM will shut OFF the fuel pump.

The pump will deliver fuel to the throttle body and injectors, then to the pressure regulator, where the system pressure is controlled to approximately 30 psi (207 kPa).

Excess fuel is then returned to the water separating fuel filter.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
- Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.
- The ability to maintain a constant fuel pressure is very critical in the driveability of fuel injection. If the fuel pressure drops below the specification of that application, multiple driveability problems may occur. The vessel may have to be operated under a load, or certain conditions, as the lack of fuel pressure may be intermittent.

Chart A-4 (2 of 2): Fuel System Diagnosis

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Install fuel pressure gauge. b. Ignition OFF. c. Ignition ON. d. Fuel pump will run for about 2 seconds. Note fuel pressure with pump running. The pressure may drop after the pump stops running, but should not drop immediately to 0 psi. ***Is fuel pressure below 25 psi (172 kPa)?***	Step 3.	Step 5.
3.	Attempt to start engine and idle at normal operating temperature. ***Did engine start?***	Step 4.	Step 6.
4.	With engine still idling, connect an external vacuum source to the fuel pressure regulator and apply 10 inches of vacuum. ***Did fuel pressure drop by approximately 5 psi (34 kPa)?***	Step 13.	Step 11.
5.	***Was fuel pressure present at all?***	Step 6.	Chart A-5
6.	***Does the system establish fuel pressure and then drop quickly to 0 psi?***	Step 7.	Step 9.
7.	a. Ignition OFF. b. Block fuel pressure line between the fuel pump and throttle body inlet fitting. c. Ignition ON. ***Does fuel pressure hold?***	Step 10.	Step 8.
8.	a. Ignition OFF. b. Block fuel return line. c. Ignition ON. ***Does fuel pressure hold?***	Step 11.	Step 12.
9.	Check for restricted fuel lines.	Verify Repair	–
10.	Locate and repair leaking injector(s) or fuel line connections.		
11.	Replace faulty fuel pressure regulator.		
12.	Check for leaking pump fittings or lines, inlet filter, and low battery voltage. If OK, replace faulty fuel pump.		
13.	Problem is intermittent or fuel supply to engine is restricted or low.		

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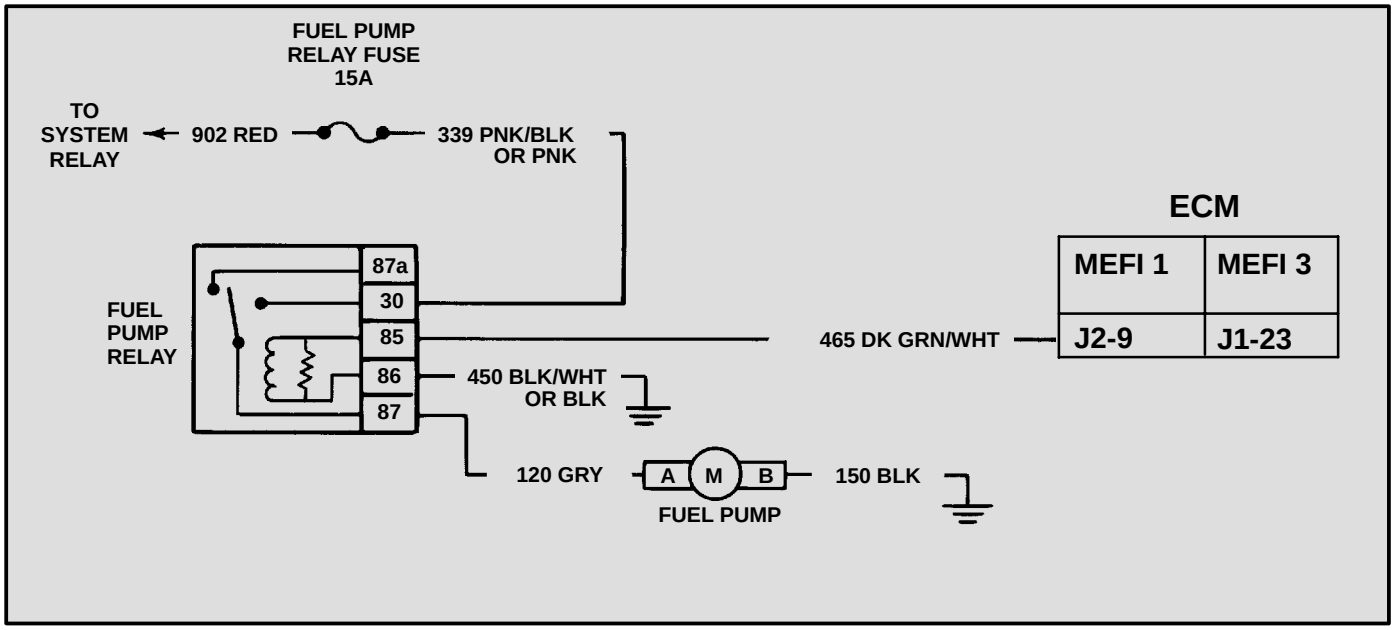
Chart A-5 (1 of 2): Fuel System Electrical Test



CIRCUIT DESCRIPTION

The fuel system circuit receives a supply voltage from the system relay CKT 902. The fuel system is protected by a 15 amp fuse. After the fuse, supply voltage is delivered by CKT 339 to fuel pump relay terminal “30.” The fuel pump relay is turned on by the ECM by supplying voltage to CKT 465. The fuel pump relay will remain ON as long as the engine is running or cranking and the ECM is receiving reference pulses. If no reference pulses are present, the ECM de-energizes the fuel pump relay within 2 seconds after the ignition is turned ON or the engine is stopped.

DIAGNOSTIC AIDS

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connections and damaged harness.
- Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.

Chart A-5 (2 of 2): Fuel System Electrical Test

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Ignition OFF. b. Remove fuel pump relay. c. Ignition ON. d. Using test light connected to ground, probe fuel pump relay harness connector terminal "30." ***Does Test Light Illuminate?***	Step 3.	Step 6.
3.	a. Ignition OFF. b. Using a fused jumper wire, connect terminals "30" and "87" of the fuel pump relay connector together. c. Ignition ON. ***Does Fuel Pump Run?***	Step 4.	Step 11.
4.	a. Ignition OFF. b. Disconnect fused jumper wire. c. Using a test light connected to battery positive (B+), probe terminal "86" of the fuel pump relay connector. ***Does The Test Light Illuminate?***	Step 5.	Step 12.
5.	a. Using a test fight connected to ground, probe terminal "85" of the fuel pump relay connector. b. Ignition ON. ***Does Test Light Illuminate For 2 Seconds And Then Go Off?***	Step 8.	Step 7.
6.	Check fuel pump relay fuse. ***Is Fuse Ok?***	Step 9.	Step 10.
7.	Locate and repair faulty ECM connection at "J2-9" or repair open in CKT 465.	Verify Repair	–
8.	Check for plugged fuel filter, vapor lock condition, restricted fuel lines, disconnected hoses, and proper fuel level.		
9.	Locate and repair open in CKT 339 or CKT 902.		
10.	Locate and repair short to ground in CKT 339 or CKT 120. Also check for contamination in fuel lines or fuel tank. If OK, replace fuel pump and fuse.		
11.	Locate and repair open in CKT 120 or CKT 150. If okay, replace faulty fuel pump.		
12.	Locate and repair open in CKT 450.		

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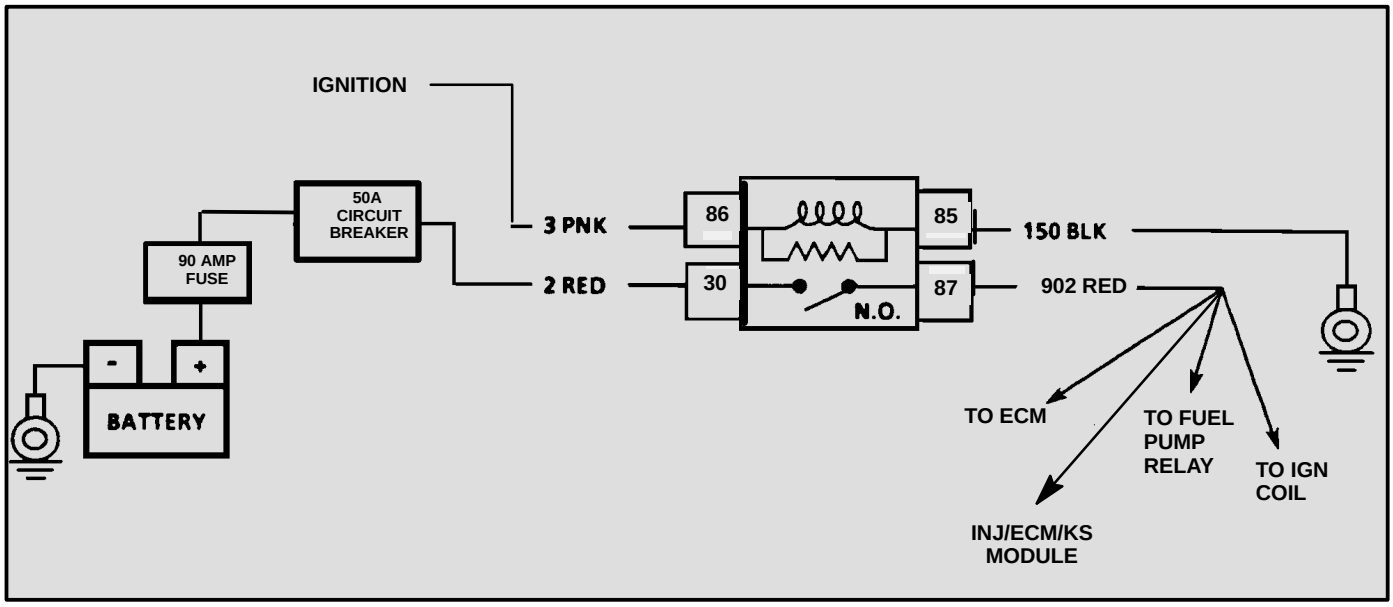
Chart A-6 (1 of 2): EFI System/Ignition Relay Check



CIRCUIT DESCRIPTION:

Battery voltage is constantly supplied to terminal “30” of the system relay. When the ignition switch is moved to the “RUN” position, battery voltage is supplied to terminal “86” of the system relay. The pull-in coil is then energized creating a magnetic field which closes the contacts of the system relay. Voltage and current are then supplied to the ignition control module, injectors, ECM and fuel pump relay through terminal “87” CKT 902 of the system relay.

DIAGNOSTIC AIDS

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

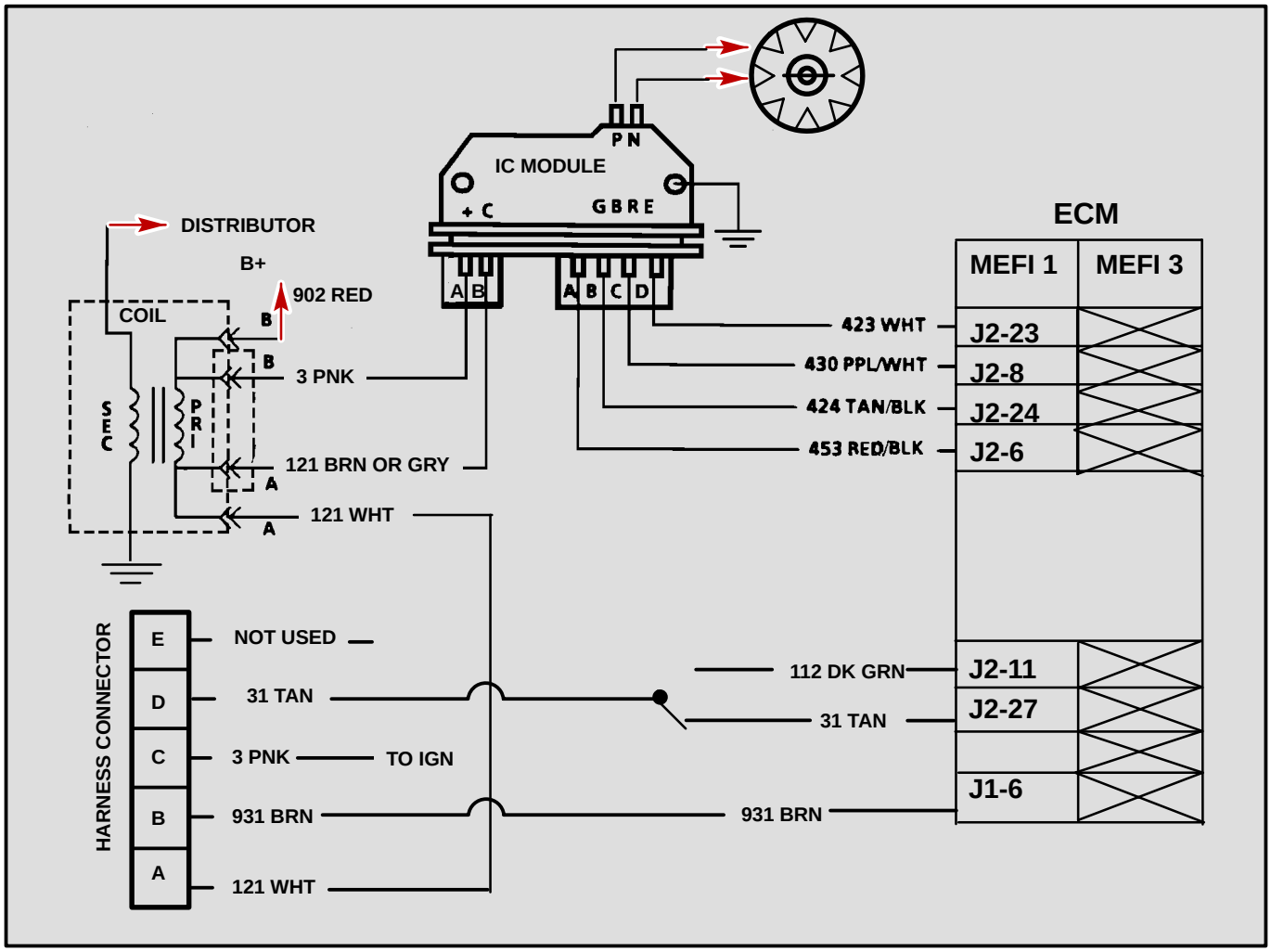
- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
- Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.

Chart A-6 (2 of 2): EFI System/Ignition Relay Check

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Ignition OFF. b. Remove EFI system relay connector. c. Ignition ON. d. With test light still connected to ground, probe relay harness connector terminals "86" and "30." ***Does Test Light Illuminate On Both Terminals?***	Step 3.	Step 5.
3.	Using test light connected to battery positive (B+), probe relay harness connector terminal "85." ***Does Test Light Illuminate?***	Step 4.	Step 6.
4.	Check relay connector for poor contact or corrosion. If OK, replace faulty EFI system relay.	Verify Repair	–
5.	Locate and repair open or short to ground in circuit that did not light (CKT 2 and/or CKT 3).		
6.	Locate and repair open ground CKT 150.		

Chart A-7 (1 of 6): Ignition System Check

MEFI 1:



CIRCUIT DESCRIPTION MEFI 1:

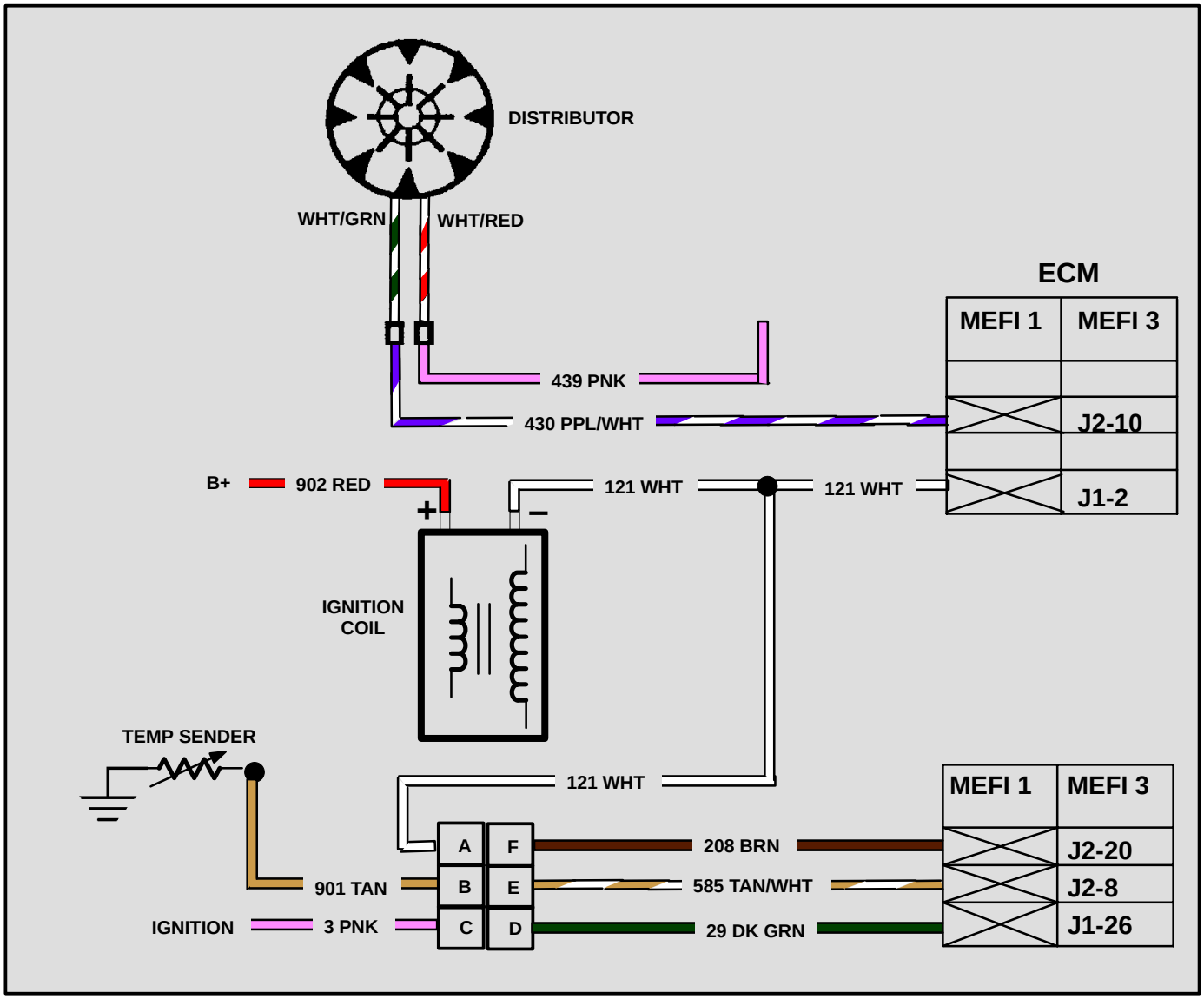
The Distributor Ignition (DI) system receives supply voltage from the system relay through CKT 902 to the ignition coil gray connector “B”. Inside the ignition coil, the gray connector terminal “B” is connected to the black connector terminal “B.” Supply voltage is delivered from the ignition coil black connector terminal “B” to the distributor Ignition Control (IC) module “+” terminal through CKT 3.

Inside the distributor, the pick-up coil and pole piece will produce a voltage signal for cylinder spark. The voltage signals are processed in the IC module and sent to the ECM. The ECM will decide if the engine is in the cranking or running mode and adjust timing accordingly. The voltages or signals are sent between the ECM and the IC module through CKT’s 423, 430 and 424. CKT 453 is the ground circuit.

The IC module will send the voltage signal to the ignition coil black connector terminal “A” through CKT 121. The signal will trigger the coil creating secondary spark to be produced. This secondary spark is sent to the distributor by a high tension lead.

Chart A-7 (2 of 6): Ignition System Check

MEFI 3



CIRCUIT DESCRIPTION MEFI 3:

The Distributor Ignition (DI) system receives supply voltage from the system relay through CKT 902 to the ignition coil positive (+) connector.

Inside the distributor, the pick-up sensor will produce a voltage signal for cylinder spark. The voltage signals are processed in the ECM. The ECM will decide if the engine is in the cranking or running mode and adjust timing accordingly.

The ECM will send a signal to the ignition coil negative (–) terminal through CKT 121. The signal will trigger the coil creating secondary spark to be produced. This secondary spark is sent to the distributor by a high tension lead.

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Chart A-7 (3 of 6): Ignition System Check

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness
- The “tach” needs to be disconnected while testing the ignition system. You will also need a place to check coil trigger voltage. By disconnecting the 5-way or 6-way harness connector, you will get test terminals to check coil trigger voltage as needed in several steps. After “tach” is disconnected, try starting the engine. If the engine starts, check for a short to ground in the boat tach circuit.
- Check all terminal connections at distributor, ignition module, and ignition coil. Is the battery OK? Is the distributor clamping screw tight?

Chart A-7 (4 of 6): Ignition System Check

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Check spark plug wires for open circuits, cracks in insulation, or improper seating of terminals at spark plugs, distributor cap, and coil tower before proceeding with this table. b. Disconnect 5-way or 6-way harness connectors. c. Install a temporary jumper wire between CKT 3 and the purple ignition lead in the harness connectors. d. Attempt to start engine and check tor secondary spark. If there is "no spark" at one wire, check a few more wires. A few sparks and then nothing is considered "no spark." ***Is Adequate Spark Present?***	Step 23.	Step 3.
3.	Remove distributor cap and verify rotation of distributor rotor. ***Is The Distributor Rotor Turning?***	Step 4.	Step 22.
4.	***Do you have a MEFI 3 ECM and a distributor with a two-wire connection?***	Step 24.	Step 5.
5.	a. Disconnect distributor 4-wire connector. b. Check for secondary spark. ***Is Adequate Spark Present?***	Step 17.	Step 6.
6.	a. Reconnect distributor 4-wire connector. b. Check for secondary spark from the coil tower using a known good coil wire. ***Is Adequate Spark Present?***	Step 18.	Step 7.
7.	a. Disconnect distributor 2-wire connector. b. Ignition ON, engine OFF. c. Using DVOM, check voltage at both terminals. ***Is Voltage Reading Greater Than 10 Volts?***	Step 8.	Step 19.
8.	a. Reconnect distributor 2-wire connector. b. Ignition ON engine OFF. c. Using DVOM, check voltage from CKT 121 tach terminal to ground. ***Is Voltage Reading Greater Than 10 Volts?***	Step 9.	Step 14.
9.	a. Using a test light connected to ground , probe CKT 121 tach terminal at the 5-way or 6-way harness connector. b. Observe the test light while cranking engine. ***Is Test Light Blinking?***	Step 12.	Step 10.

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Chart A-7 (5 of 6): Ignition System Check

Step	Action	Yes	No
		PROCEED TO	
10.	a. Disconnect distributor 4-wire connector. b. Remove distributor cap. c. Disconnect pick-up coil connector from the distributor ignition control module. d. Connect DVOM to CKT 121 tach terminal at the 5-way or 6-way harness connector and ground. e. Ignition ON, engine OFF. f. Connect positive (+) end of a known good 1.5 volt test battery to the “P” terminal on the distributor ignition control module. Observe the voltage at the tach terminal as the negative (-) end of the test battery is momentarily grounded to a known good ground. ***Does The Voltage Drop?***	Step 11.	Step 20.
11.	Check for spark from the coil wire as the test battery lead is removed? ***Is Adequate Spark Present?***	Step 16.	Step 12.
12.	Replace ignition coil and recheck for spark using Steps 10. and 11. ***Is Adequate Spark Present?***	Step 13.	–
13.	Reinstall coil and check coil wire from distributor cap. If OK, replace ignition module.	Verify Repair	–
14.	Check for faulty connections or open tach lead. If OK, replace ignition module and recheck for spark using Steps 10. and 11. ***Is Adequate Spark Present?***		Step 15.
15.	Replace ignition coil.		–
16.	***Is the rotating pole piece still magnetized?***	Step 17.	Step 21.
17.	Replace faulty pick-up coil.	Verify Repair	–
18.	Inspect distributor cap for water, cracks, etc. If OK, replace faulty distributor rotor.		
19.	Check for open or short to ground in CKT 3, open CKT 902, open or short to ground in CKT 121. If OK, replace faulty ignition coil.		
20.	Check ignition module ground. If OK, replace faulty ignition module.		
21.	Replace distributor pole piece and shaft assembly.		
22.	A mechanical repair will be necessary before continuing with this test.		
23.	Locate and repair intermittent faulty connections.		

Chart A-7 (6 of 6): Ignition System Check

Step	Action	Yes	No
		PROCEED TO	
24.	With key in RUN position, measure voltage at positive (+) terminal on ignition coil. ***Is Voltage Greater Than 10 Volts?***	Step 25.	Chart A–6
25.	Unplug WHT/RED bullet connectors from distributor and measure voltage on CKT 439 from harness. ***Is Voltage Greater Than 10 Volts?***	Step 26.	Step 28.
26.	a. Reconnect WHT/RED bullet connectors. b. Remove high tension lead from distributor at coil. c. Insert a spark gap tester from coil tower to ground. d. Disconnect WHT/GRN lead from distributor. e. Ignition ON. f. Rapidly (2 – 3 times per second) strike the terminal of the PPL/WHT lead from the harness against ground (–). ***Is There Spark at Coil?***	Step 29.	Step 27.
27.	a. Substitute a new ignition coil. b. Repeat above test. ***Is There Spark at Coil?***	Step 30.	Step 31.
28.	Check IGN / INJ fuse. ***Is Fuse Good?***	Step 32.	Step 33.
29.	Replace ignition sensor in distributor.	Verify Repair	–
30.	Install new ignition coil.		
31.	Repair CKT 430.		
32.	Repair open CKT 439 to distributor.		
33.	Replace fuse.		

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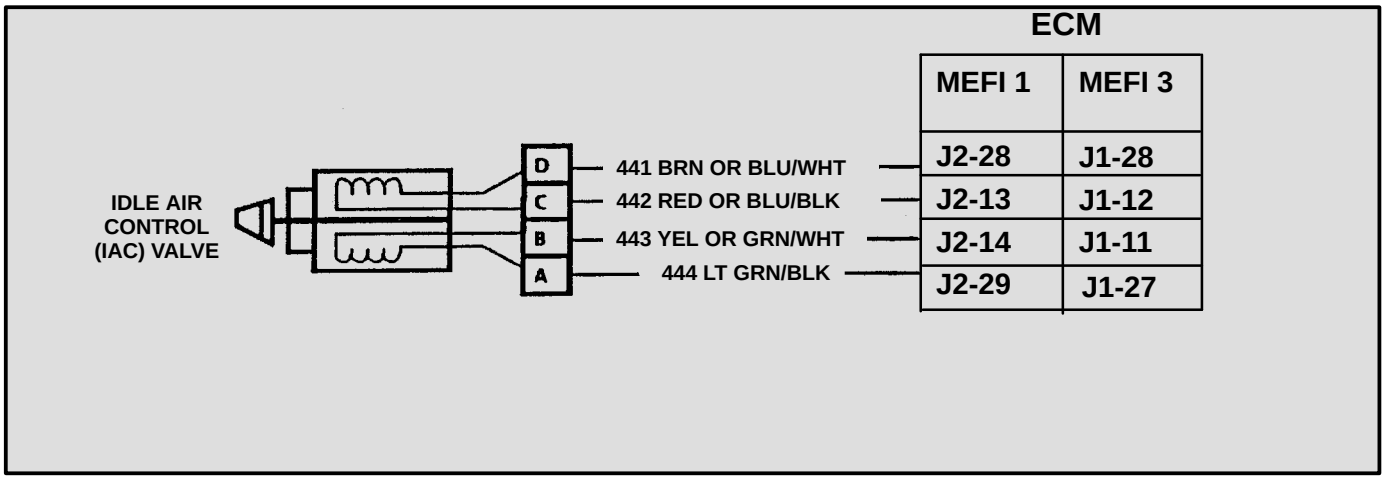
Chart A-8 (1 of 2): Idle Air Control (IAC) Functional Test



CIRCUIT DESCRIPTION:

The ECM controls idle speed to a calibrated “desired” rpm based on sensor inputs and actual engine rpm. The ECM uses four (4) circuits to move the Idle Air Control (IAC) valve. The movement of the IAC valve varies the amount of air flow bypassing the throttle plates. The ECM controls idle speed by determining the position of the IAC valve.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.
- Check for vacuum leaks, disconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold.
- Check for poor connections, opens, or short to grounds in CKT’s 441, 442, 443, and 444. This may result in improper idle control.
- An IAC valve which is “frozen” and will not respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage may cause improper idle.

Chart A-8 (2 of 2): Idle Air Control (IAC) Functional Test

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Engine should be at normal operating temperature. b. Start engine and allow idle to stabilize. c. Record rpm. d. Ignition OFF for 10 seconds. e. Disconnect IAC harness connector. f. Restart engine and record rpm. ***Is rpm Higher Than The First Recorded rpm By More Than 200 rpm?***	Step 3.	Step 4.
3.	a. Reinstall IAC harness connector. b. Idle speed should gradually return within 75 rpm of the original recorded rpm within 30 seconds. ***Does rpm Return To Original Recorded rpm?***	Step 5.	Step 4.
4.	a. Ignition OFF for 10 seconds. b. Disconnect IAC harness connector. c. Restart engine. d. Using a test light connected to ground, probe each one of the four IAC harness terminals. ***Does The Test Light Blink On All Four Terminals?***	Step 7.	Step 6.
5.	IAC circuit is functioning properly.	–	–
6.	Locate and repair poor connection, open, or short to ground in the IAC circuit that did not blink or repair faulty ECM connections	Verify Repair	
7.	Check for poor IAC connections or replace the faulty IAC valve.		

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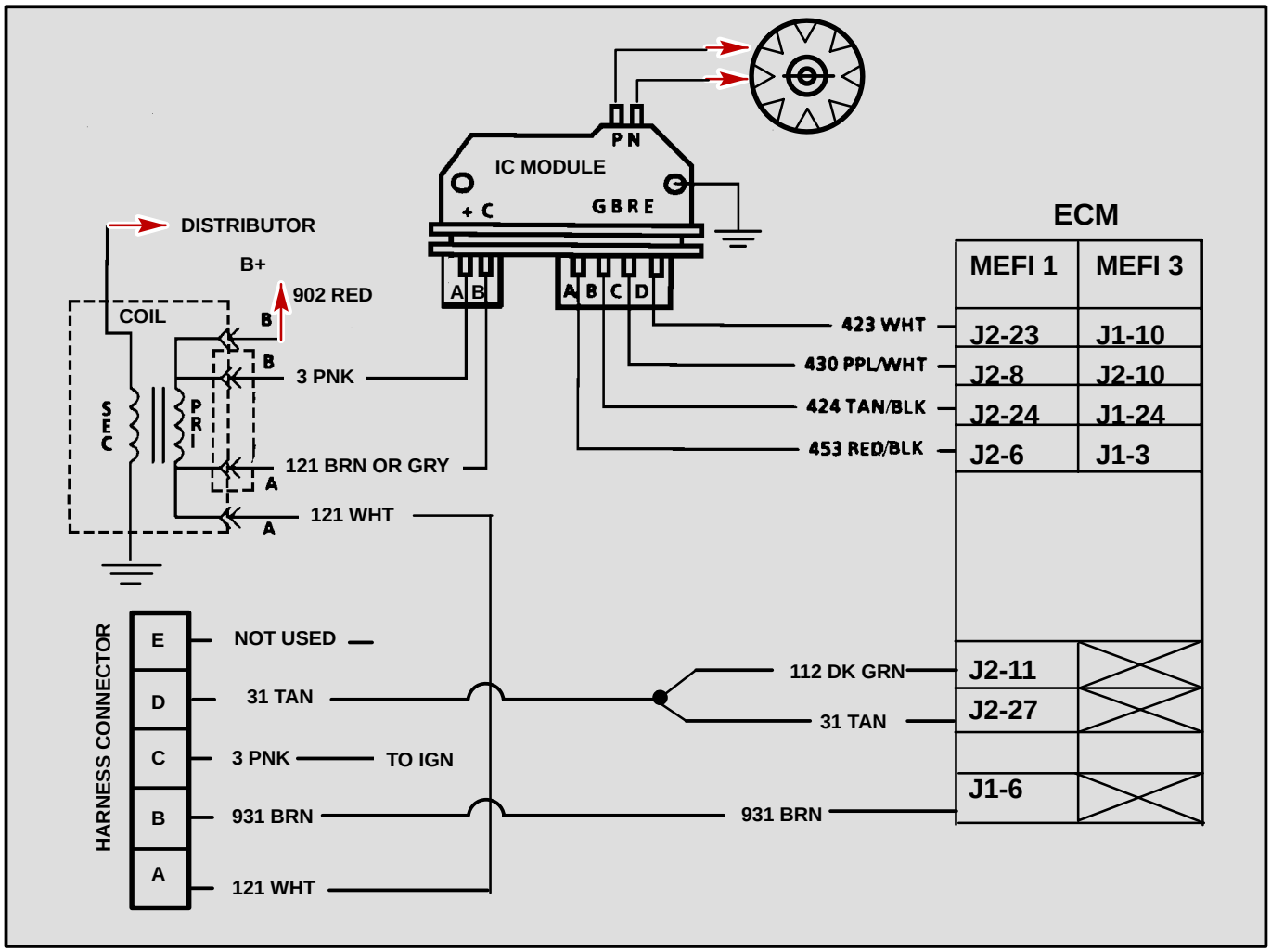
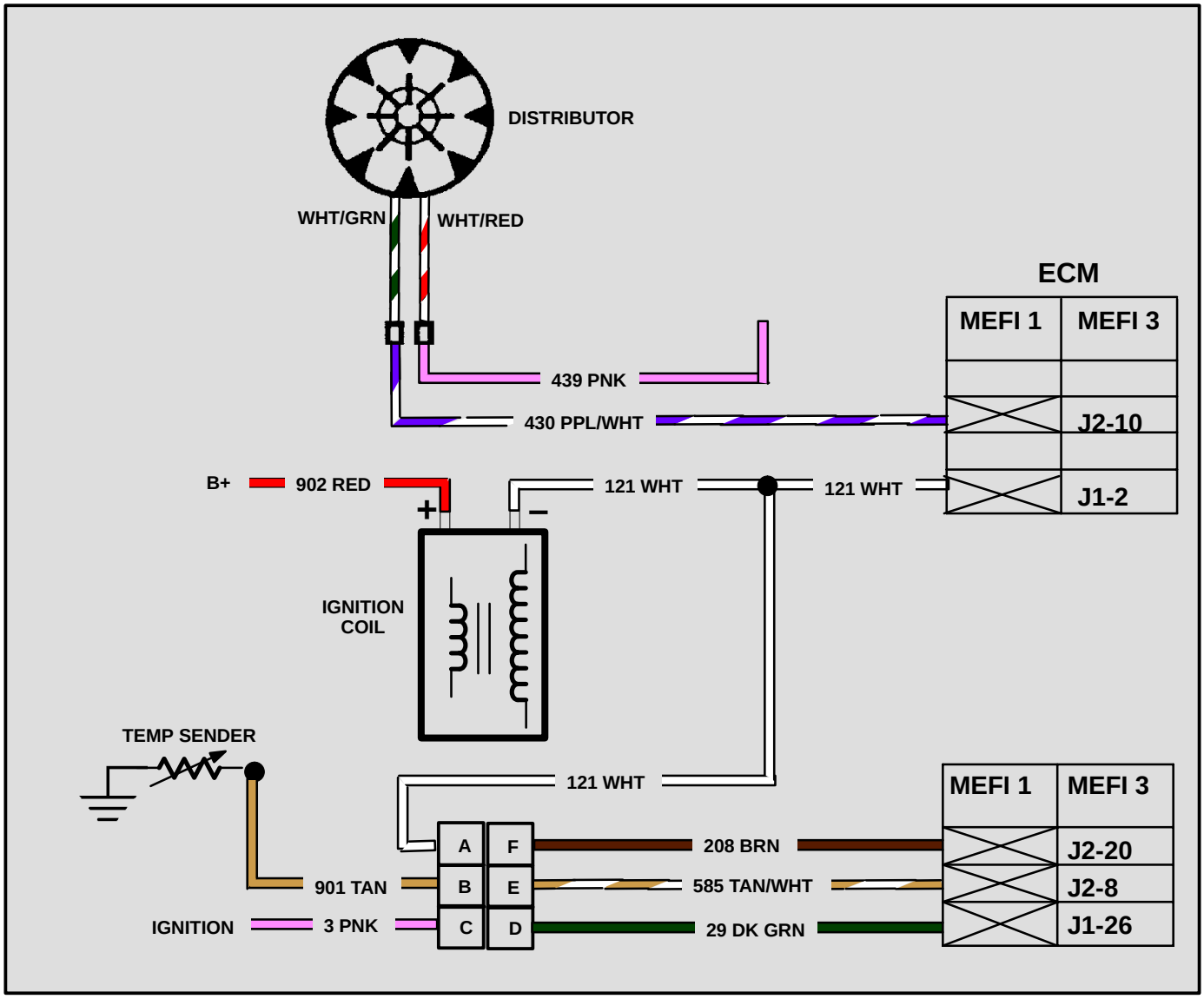
Discrete Input Circuit Check - Non-Scan Only (1 of 5)

MEFI 1



MEFI 3



CIRCUIT DESCRIPTION:

Several discrete switch inputs are utilized by the fuel injection system to identify abnormal conditions that may affect engine operation. A pull-up switch is currently used in conjunction with the ECM to detect critical conditions to engine operation.

If a discrete switch changes states from its normal at-rest position, that is normally open to closed (or closed to open), the ECM senses a change in voltage and responds by activating the audio warning system.

DIAGNOSTIC AIDS:

- Check engine oil and gear lube levels.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, or a wire that is broken inside the insulation.

Discrete Input Circuit Check(2 of 5)

NOTE: *The ECM should only be replaced after all switches and circuits have been tested and found to be functioning properly.*

TESTING BUZZER

Step	Action	Yes	No
		PROCEED TO	
1.	Key ON, Engine OFF. ***Does buzzer sound?***	Step 2.	OBD
2.	Start engine. ***Does buzzer sound?***	Step 3.	Step 6.
3.	a. Disconnect TAN/BLU or BLU wire at buzzer. b. Key ON, Engine OFF. c. Touch TAN/BLU or BLU wire to ground (–). ***Does buzzer sound?***	Step 4.	Step 5.
4.	Buzzer is working properly. Proceed to “Testing Switches” or “Testing Circuits.”	–	–
5.	Ensure that there is battery power (+) to the PUR wire going to buzzer. If there is, replace buzzer.	Verify Repair.	–
6.	Discrete switches may all be functioning properly. Proceed to check all discrete circuits to verify each works properly.	Verify Repair.	–

TESTING OIL PRESSURE SWITCH

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect MEFI 1 BLU/TAN or MEFI 3 BLU wire from oil pressure switch. b. Engine OFF. c. Check for continuity between terminal on switch and ground (–). ***Is there continuity?***	Step 2.	Step 3.
2.	a. Start engine. b. Check for continuity between terminal on switch and ground (–). ***Is there continuity?***	Step 3.	Switch OK
3.	Replace oil pressure switch.	Verify Repair.	–

Discrete Input Circuit Check (3 of 5)

TESTING GEAR LUBE MONITOR SWITCH

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect BLU/TAN or TAN/WHT wire from gear lube monitor. b. Empty gear lube from monitor. c. Check for continuity between TAN/BLU wire and ground (–). ***Is there continuity?***	Step 2.	Step 3.
2.	a. Refill gear lube monitor. b. Check for continuity between TAN/BLU wire and ground (–). ***Is there continuity?***	Step 3.	Switch OK
3.	Replace gear lube monitor.	Verify Repair.	–

Discrete Input Circuit Check (4 of 5)

TESTING CIRCUITS FOR SHORT-TO-GROUND (–)

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect BLU/TAN or BLU wire from oil pressure switch. b. Disconnect BLU/TAN or TAN/WHT wire from gear lube monitor. c. Disconnect BLU/TAN wire from transmission temperature switch (if equipped). d. Key ON, engine OFF. ***Does audio warning buzzer sound?***	Step 2.	Step 3.
2.	a. Key OFF. b. Disconnect ECM connectors. c. Check for continuity between all wires disconnected in Step 1. and engine ground (–). ***Is there continuity on MEFI 1 BLU/TAN or MEFI 3 BLU wire from oil pressure switch?*** ***Is there continuity on MEFI 1 BLU/TAN or MEFI 3 TAN/WHT wire from gear lube switch?*** ***Is there continuity on BLU/TAN wire from transmission switch?***	Step 4.	Step 3.
3.	Circuit(s) is not shorted to ground (–). Check switches.	–	–
4.	Repair short-to-ground (–) in affected circuit.	–	–

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Discrete Input Circuit Check (5 of 5)

TESTING FOR OPEN CIRCUITS

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect BLU/TAN or BLU wire from oil pressure switch. b. Disconnect BLU/TAN or TAN/WHT wire from gear lube monitor. c. Disconnect BLU/TAN wire from transmission temperature switch (if equipped). d. Key ON, engine OFF. e. One at a time, touch each wire to ground (–) that was disconnected. ***Does audio warning buzzer sound when grounding MEFI 1 BLU/TAN or MEFI 3 BLU wire from oil pressure switch?*** ***Does audio warning buzzer sound when grounding MEFI 1 BLU/TAN or MEFI 3 TAN/WHT wire from gear lube switch?*** ***Does audio warning buzzer sound when grounding BLU/TAN wire from transmission switch?***	Step 3.	Step 2.
2.	a. Key OFF. b. Disconnect ECM connectors. ***Is there continuity on MEFI 1 BLU/TAN or MEFI 3 BLU wire from oil pressure switch to ECM CKT?*** ***Is there continuity on MEFI 1 BLU/TAN or MEFI 3 TAN/WHT wire from gear lube switch to ECM CKT?*** ***Is there continuity on BLU/TAN wire from transmission switch to ECM CKT?***	Step 3.	Step 4.
3.	Circuit(s) is not open.	–	–
4.	Repair open circuit.	–	–

Clearing Trouble Codes

Clearing Codes Using CodeMate Tester

NOTE: *When clearing codes without the use of a scan tool, the battery must be fully charged. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking rpm.*

1. Install diagnostic CodeMate Tester.
2. Turn key ON.
3. Select “Service Mode” on CodeMate Tester.
4. To clear codes, move the throttle, while in NEUTRAL, from 0% to 100% then back to 0%.
5. Exit “Service Mode” on CodeMate Tester.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select “Service Mode” on CodeMate Tester.
9. Turn key ON and read codes. If codes are still present, check preceding “Note” and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts.

A poorly charged battery or engine cranking problem may result in an ECM “reset” and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged.

NOTE: *If a low battery condition does exists the audio warning buzzer will come on for 2 seconds (as a result of an ECM reset) after engine start-up.*

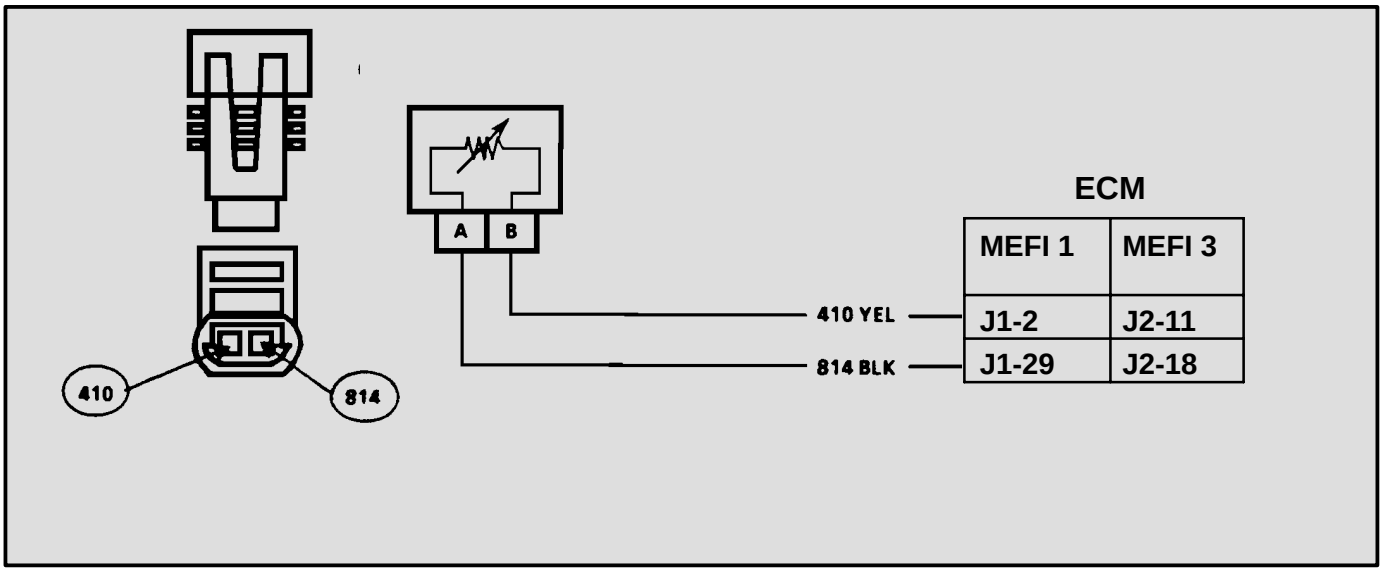
Clearing Codes Using Scan Tool

IMPORTANT: All references to Scan Tool work with either the Quicksilver Digital Diagnostic Tool or the Rinda Scan Tool.

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, there is a real fault in system. Refer to appropriate Troubleshooting and/or Diagnostic Charts.

Diagnostic Testing

Code 14 (1 of 3): Engine Coolant Temperature (ECT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. Therefore, the ECM will see high signal voltage. As the engine coolant warms, the sensor resistance becomes less and the voltage drops.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- A scan tool displays engine coolant temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- Check harness routing for a potential short to ground in CKT 410.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 14 (2 of 3): Engine Coolant Temperature (ECT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 8.
3.	a. Ignition ON. ***Does scan tool display a coolant temperature value greater than 266° F (130° C) or less than -22° F (-30° C)?***	Step 4.	Step 5.
4.	***Does scan tool display a coolant temperature value greater than 266° F (130° C)?***	Step 6.	Step 7.
5.	Code 14 is intermittent. If no additional codes were stored, refer to "Diagnostic Aids."	–	–
6.	a. Ignition OFF. b. Disconnect ECT sensor. c. Ignition ON. ***Does scan tool display coolant temperature below -22° F (-30° C).***	Step 12.	Step 14.
7.	a. Ignition OFF. b. Disconnect ECT sensor. c. Jumper terminals "A" and "B" together. d. Ignition ON. ***Does scan tool display coolant temperature above 266° F(130° C).***	Step 12.	Step 15.
8.	***NOTE:*** *Following steps do not require a Scan Tool.* a. Ignition OFF. b. Disconnect ECT sensor connector. c. Ignition ON, engine OFF. d. Connect DVOM across coolant sensor harness terminals. ***Is voltage above 4 volts?***	Step 12.	Step 9.
9.	a. Connect positive DVOM lead from harness terminal "B" CKT 410 (5 volt reference). b. Connect negative DVOM lead to a good ground (–) on engine. ***Is voltage above 4 volts?***	Step 16.	Step 10.

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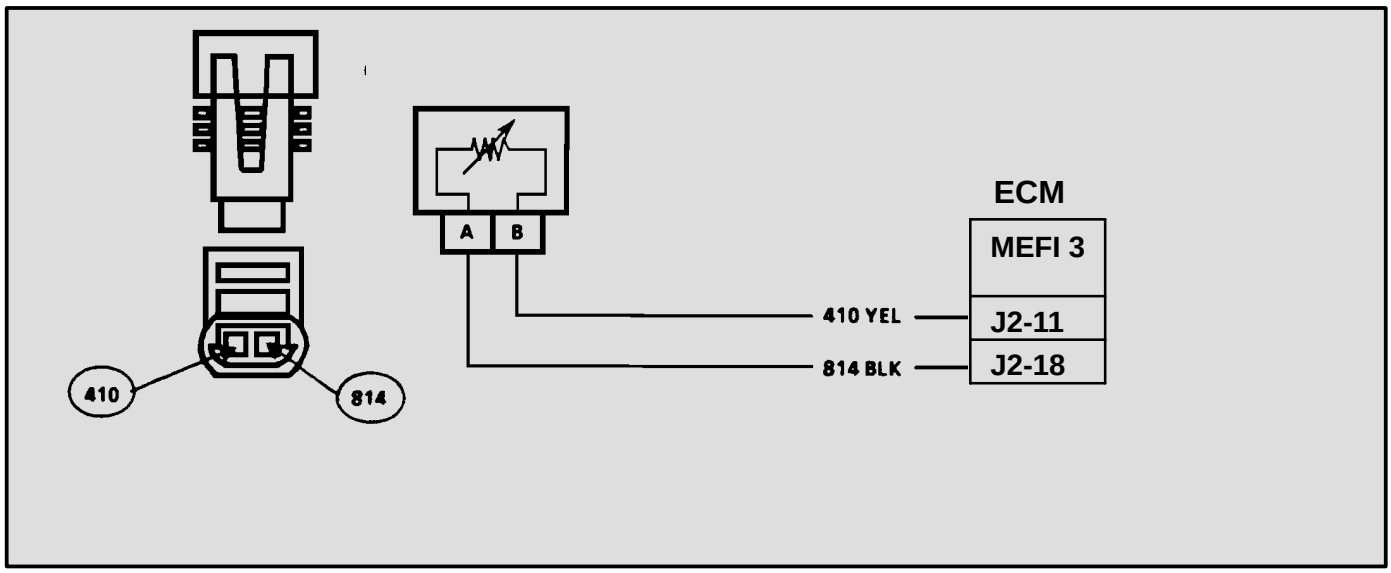
Code 14 (3 of 3): Engine Coolant Temperature (ECT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
10.	a. Remove DVOM. b. Ignition ON. c. Connect a test light to battery positive (B+). d. Touch test light to sensor harness terminal “B” CKT 410. ***Is test light on?***	Step 13.	Step 11.
11.	Locate and repair open in CKT 410 or faulty connection at ECM.	–	–
12.	Locate and repair Intermittent connections or replace faulty ECT sensor (refer to chart below for sensor values).	–	–
13.	For MEFI 1, disconnect J-1 connector. For MEFI 3, disconnect J-2 connector. ***Is test light on?***	Step 14.	Step 15.
14.	CKT 410 shorted to ground. Locate and repair short.	–	–
15.	CKT 410 shorted to sensor ground or faulty ground. Locate and repair.	–	–
16.	Locate and repair open sensor ground in CKT 814 or faulty connection at ECM.	–	–

ENGINE COOLANT TEMPERATURE SENSOR CHART

ECT Sensor Temperature - to - Resistance Values (Approximate)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Code 15 (1 of 2): Engine Coolant Temperature (ECT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the engine coolant warms, the sensor resistance becomes less, and the voltage drops.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- A scan tool displays engine coolant temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- Check harness routing for a potential short to ground in CKT 410.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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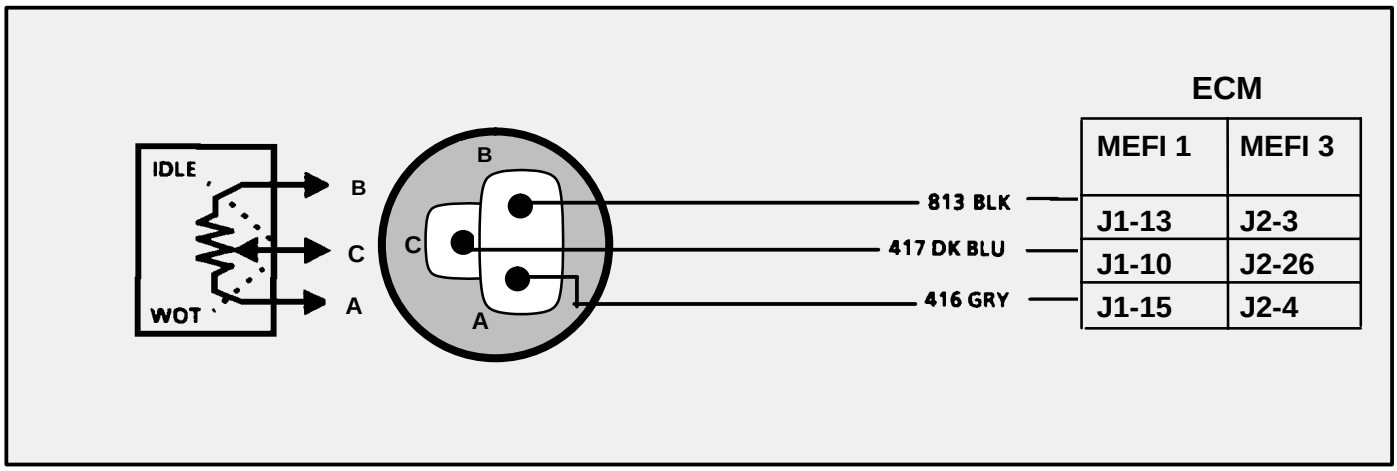
Code 15 (2 of 2): Engine Coolant Temperature (ECT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 5.
3.	Ignition ON. ***Does the scan tool display a coolant temperature greater than 266°F (130°C)?***	Step 4.	Step 6.
4.	a. Ignition OFF. b. Disconnect ECT harness connector. c. Ignition ON, engine OFF. ***Does scan tool display a coolant temperature below -22°F (-30°C)?***	Step 6.	Step 7.
5.	a. Ignition OFF. b. Disconnect ECT sensor harness terminals. c. Ignition ON, engine OFF. d. Connect DVOM across the coolant sensor harness terminals. ***Is voltage above 4 Volts?***	Step 6.	Step 7.
6.	Locate and repair intermittent faulty connections or replace faulty ECT sensor.	Verify Repair	–
7.	Locate and repair short to ground in CKT 410 or repair faulty ECM connections. ***Was a problem found?***		

Code 21 (1 of 3): Throttle Position (TP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Throttle Position (TP) Sensor provides a voltage signal that changes as throttle blades open or close. Signal voltage should vary from about .5 volts at idle to about 4.5 volts at Wide Open Throttle (WOT).

The TP signal is one of the most important inputs used by the Electronic Control Module (ECM) for fuel control and for most of the ECM controlled outputs.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening With ignition ON, engine OFF, throttle blades closed (idle), the voltage should be 0.3-0.8 volts The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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Code 21 (2 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	a. Throttle closed. b. Ignition ON. ***Does scan tool indicate throttle position sensor voltage greater than 4 volts?*** ***Does scan tool indicate throttle position sensor voltage less than .3 volts?***	Step 6. Step 5.	Step 4. Step 4.
4.	Code 21 is intermittent, refer to "Diagnostic Aids" on facing page.	–	–
5.	a. Ignition OFF. b. Disconnect throttle position sensor electrical connector. Jumper throttle position sensor harness terminals "A" and "C" together. c. Ignition ON ***Does scan tool indicate throttle position sensor voltage greater than 4 volts?***	Step 15.	Step 7.
6.	a. Ignition OFF. b. Disconnect throttle position sensor connector. c. Ignition ON. ***Does scan tool indicate voltage over 4 volts?***	Step 13.	Step 7.
7.	a. Ignition OFF. b. Disconnect throttle position sensor harness connector. c. Ignition ON. d. Connect DVOM from harness terminal "A" (5 volt reference to harness terminal "B" (sensor ground). ***Is voltage reading over 4 volts?***	Step 8.	Step 11.
8.	Connect DVOM from harness terminal "A" (CKT 416) to harness terminal "C" (throttle position sensor signal, CKT 417). ***Is voltage reading over 4 volts?***	Step 9.	Step 10.

Code 21 (3 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	a. Ignition OFF. b. Connect a test light to battery positive (B+). c. Touch test light to harness terminal “C” (throttle position sensor signal). ***Is test light on?***	Step 12.	Step 15.
10.	Connect DVOM between harness terminal “C” and engine ground (–). ***Is voltage reading over 4 volts?***	Step 13.	Step 14.
11.	Connect DVOM from throttle position sensor harness terminal “A” to a good ground on engine. ***Is voltage reading over 4 volts?***	Step 18.	Step 17.
12.	a. Disconnect ECM. b. Touch test light to harness terminal “C” (throttle position sensor signal). ***Is test light on?***	Step 16.	Step 14.
13.	Check for CKT 417 shorted to voltage.	–	–
14.	Locate and repair open in CKT 417 or faulty connection at ECM.	–	–
15.	Replace throttle position sensor.	–	–
16.	Check for CKT 417 shorted to ground.	–	–
17.	CKT 416 open or shorted to ground or faulty connection at ECM.	–	–
18.	CKT 813 open faulty connection at ECM.	–	–

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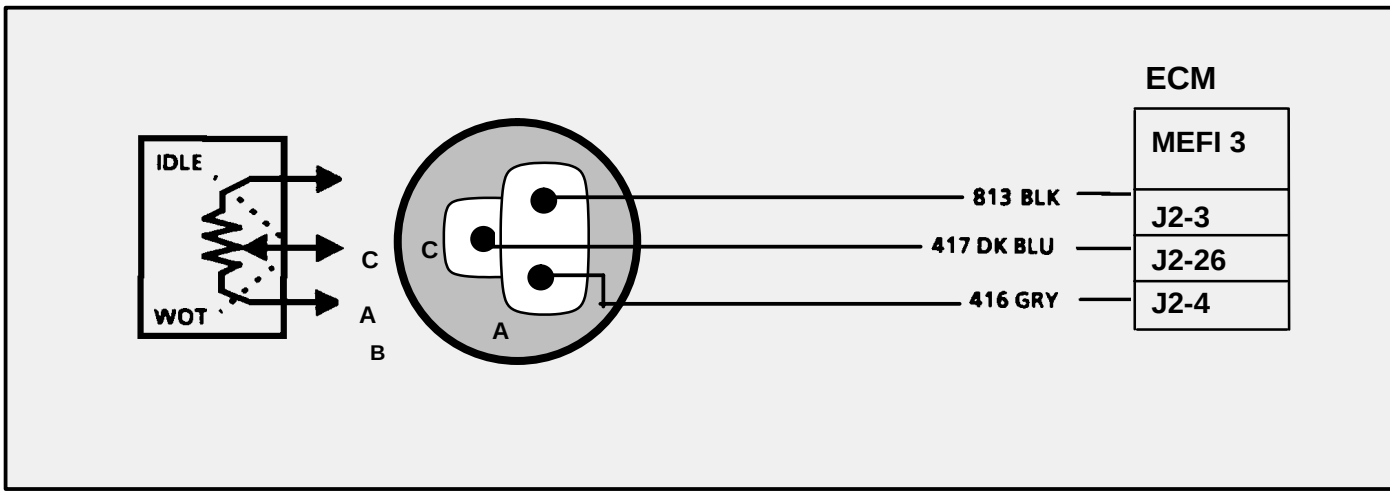
Code 22 (1 of 3): Throttle Position (TP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Throttle Position (TP) Sensor provides a voltage signal that changes as throttle blades open or close. Signal voltage should vary from about .5 volts at idle to about 4.5 volts at Wide Open Throttle (WOT).

The TP signal is one of the most important inputs used by the Electronic Control Module (ECM) for fuel control and for most of the ECM controlled outputs.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening With ignition ON, engine OFF, throttle blades closed (idle), the voltage should be 0.3-0.8 volts The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 22 (2 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	a. Throttle closed. b. Ignition OFF. ***Does scan tool indicate TP sensor voltage less than .30 volt?***	Step 4.	Step 6.
4.	a. Ignition OFF b. Disconnect TP sensor harness connector. c. Connect a jumper wire from harness terminal "A" CKT 416 to harness terminal "B" CKT 417. d. Ignition ON, engine OFF. ***Does scan tool indicate TP sensor voltage greater than 4 volts?***	Step 9.	Step 5.
5.	a. Ignition OFF. b. Connect DVOM from harness terminal "A" (CKT 416) to a known good ground. ***Does scan tool indicate TP sensor voltage greater than the specified value?***	Step 10.	Step 11.
6.	Trouble code 22 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."	–	–
7.	a. Switch CodeMate Tester to the normal mode. b. Ignition OFF. c. Disconnect throttle sensor harness connector. d. Connect a jumper wire form harness terminal "A" CKT 416 to harness terminal "C" CKT 417. e. Start engine and idle for 2 minutes or until CodeMate Tester indicates a stored trouble code, whichever occurs first. f. Ignition ON, engine OFF. g. Switch CodeMate Tester to "Service Mode" and note trouble code. ***Is trouble code 21 present?***	Step 9.	Step 10.
8.	a. Remove jumper wire from CKT 416 and CKT 417. b. Connect DVOM from harness terminal "A" CKT 416 to harness terminal "B" CKT 813. ***Is voltage reading above 4 volts?***	Step 10.	Step 11.

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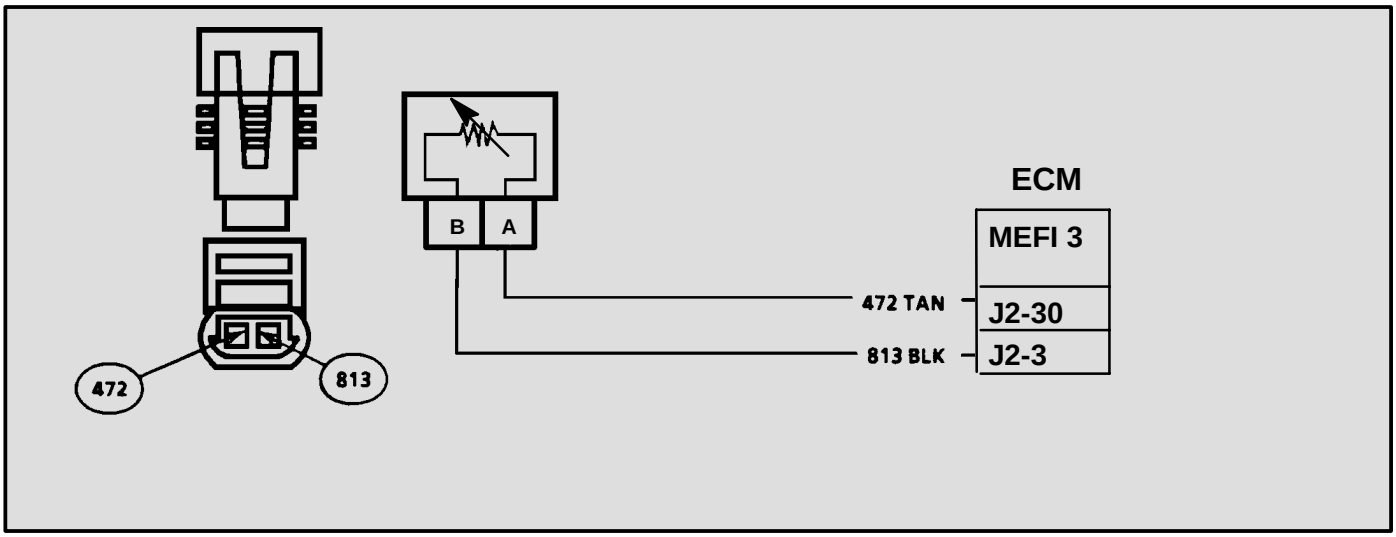
Code 22 (3 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	Locate and repair intermittent faulty connections or replace faulty throttle position sensor.	Verify Repair	–
10.	Locate and repair open or short to ground in CKT 417 or faulty ECM connections.		–
11.	Locate and repair open or short to ground in CKT 416 or faulty ECM connections.		–

Code 23 (1 of 3): Intake Air Temperature (IAT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 472 to the sensor. When the intake air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the intake air warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, 160-180°F (71-82°C), the voltage will measure about 1.5 to 2.0 volts.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees Celsius and Fahrenheit. If the intake air is cold (not running within 8 hours), the scan tool should display a IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature.
- If DTC 21 is also set, check for open ground CKT 813.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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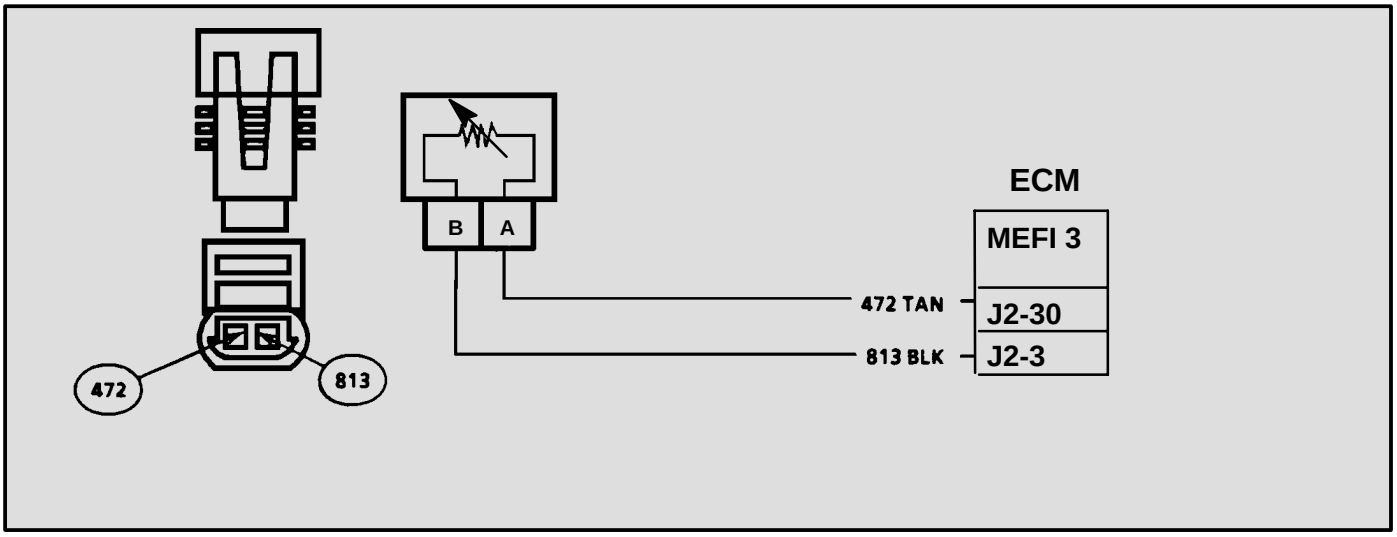
Code 23 (2 of 3): Intake Air Temperature (IAT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	Ignition ON ***Does the scan tool display a temperature less than -22°F (-30°C)?***	Step 4.	Step 5.
4.	a. Ignition OFF b. Disconnect IAT harness connector. c. Connect a jumper wire from harness terminal "A" CKT 472 to harness terminal "B" CKT 813. d. Ignition ON, engine OFF. ***Does scan tool display a temperature above 266°F (130°C)?***	Step 9.	Step 6.
5.	Trouble code 23 is intermittent. Locate and repair intermittent faulty connections.	Verify Repair	–
6.	Locate and repair open in CKT 472 or CKT 813.		
7.	a. Ignition OFF. b. Disconnect IAT sensor harness terminals. c. Ignition ON, engine OFF. 4. Connect DVOM across the sensor harness terminals. ***Is voltage above 4 volts?***	Step 9.	Step 8.
8.	a. Connect positive (+) DVOM lead to harness terminal "B" CKT 472 (5 volt reference). b. Connect negative (–) DVOM lead to a known good ground. ***Is voltage above 4 volts?***	Step 11.	Step 10.
9.	Locate and repair intermittent faulty connections. If OK, replace faulty IAT sensor.	Verify Repair	–
10.	Locate and repair open CKT 472 or faulty ECM connections.		–
11.	Locate and repair open ground CKT 813 or faulty ECM connections.		–

Code 25 (1 of 3): Intake Air Temperature (IAT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 472 to the sensor. When the intake air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the intake air warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, 160-180°F (71-82°C), the voltage will measure about 1.5 to 2.0 volts.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature.
- Check harness routing for a potential short to ground in CKT 472.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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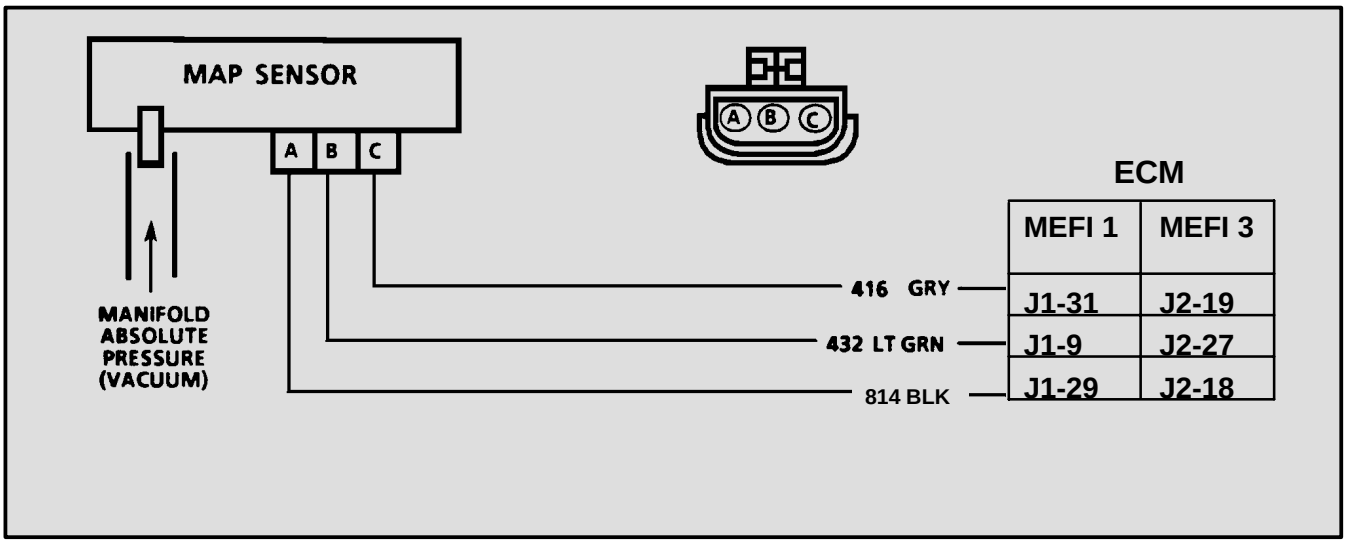
Code 25 (2 of 2): Engine Coolant Temperature (IAT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	Ignition ON. ***Does the scan tool display a temperature greater than 266°F (130°C)?***	Step 4.	Step 5.
4.	a. Ignition OFF. b. Disconnect IAT harness connector. c. Ignition ON, engine OFF. ***Does scan tool display a temperature below -22°F (-30°C)?***	Step 8.	Step 6.
5.	Trouble code 25 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."	Verify Repair	–
6.	Locate and repair short to ground in CKT 472. If a problem is found, repair as necessary. ***Was a problem found?***		Step 10.
7.	a. Ignition OFF. b. Disconnect IAT sensor harness terminals. c. Ignition ON, engine OFF. d. Connect DVOM across the sensor harness terminals. ***Is voltage above 4 volts?***	Step 8.	Step 9.
8.	Locate and repair intermittent faulty connections or replace faulty IAT sensor.	Verify Repair	–
9.	Locate and repair short to ground in CKT 472.		Step 10.
10.	Repair faulty ECM connections.		–

Code 33 (1 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-2.0 volts at idle to about 4.0-5.0 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with rpm.

A reference voltage of 5 volts is provided to the MAP sensor through CKT 416. CKT 814 is the ground circuit for the MAP sensor. MAP sensor CKT 432 will send a voltage signal to the ECM proportional to the manifold pressure.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to “Troubleshooting” section for items which may cause an unstable idle.
- With the ignition ON, engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a “suspect” sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground CKT 814.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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Code 33 (2 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	a. Ignition OFF. b. Install a vacuum gauge to manifold vacuum. c. Start engine and raise rpm to 1000 in NEUTRAL. ***Is the vacuum reading steady and above 14 in. HG (45.5 kPa)?***	Step 4.	Step 10.
4.	Allow the engine to idle. ***Does the scan tool indicate MAP sensor voltage greater than 4 volts?***	Step 5.	Step 11.
5.	a. Ignition OFF. b. Disconnect MAP sensor harness connector. c. Ignition ON, engine OFF. ***Does the scan tool indicate MAP sensor voltage less than 1 volt?***	Step 6.	Step 13.
6.	a. Ignition OFF. b. Connect DVOM from harness terminal "A" CKT 814 to harness terminal "C" CKT 416. c. Ignition ON, engine OFF. ***Does the scan tool indicate MAP sensor voltage greater than 4 volts?***	Step 12.	Step 14.
7.	a. Ignition OFF. b. Install a vacuum gauge. c. Start engine and raise rpm to 1000 in NEUTRAL. ***Is the vacuum reading steady and above 14 In. Hg (45.5 kPa)?***	Step 8.	Step 10.

Code 33 (3 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
8.	a. Switch CodeMate Tester to the “Normal Mode.” b. Ignition OFF. c. Disconnect MAP sensor harness connector. d. Start engine and idle for 2 minutes or until CodeMate Tester indicates a stored trouble code, whichever occurs first. e. Ignition ON, engine OFF. f. Switch CodeMate Tester to the “Service Mode and note trouble code. ***Is trouble code 34 present?***	Step 12.	Step 9.
9.	a. MAP sensor harness connector disconnected. b. Ignition ON engine OFF. c. Connect DVOM from harness terminal “A” CKT 814 to harness terminal “C” CKT 416. ***Is voltage reading above 4 volts?***	Step 13.	Step 14.
10.	Repair low or unsteady vacuum problem.	Verify Repair	–
11.	Trouble code is intermittent. Locate and repair intermittent faulty connections. Refer to “Diagnostic Aids.”		–
12.	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor.		–
13.	Locate and repair short to voltage in CKT 432 or faulty ECM connections.		–
14.	Locate and repair open in CKT 814 or repair faulty ECM connections.		–

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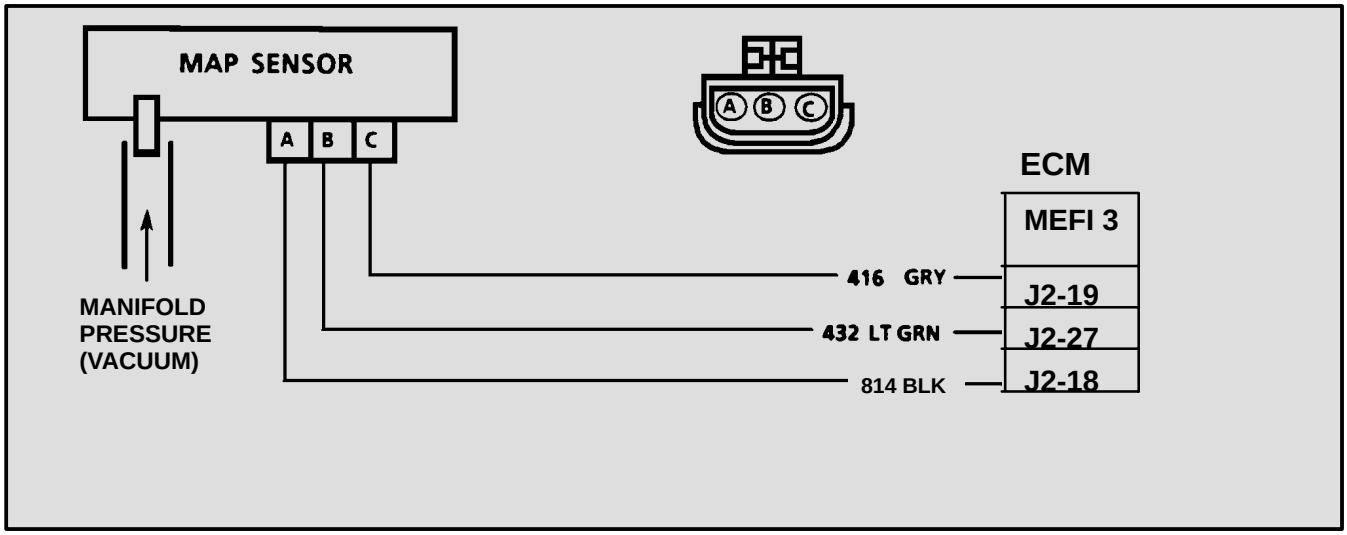
Code 34 (1 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-2.0 volts at idle to about 4.0-5.0 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with rpm.

A reference voltage of 5 volts is provided to the MAP sensor through CKT 416. CKT 814 is the ground circuit for the MAP sensor. MAP sensor CKT 432 will send a voltage signal to the ECM proportional to the manifold pressure.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to “Troubleshooting” section for items which may cause an unstable idle.
- With the ignition ON, engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a “suspect” sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground CKT 814.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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Code 34 (2 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	a. Ignition OFF b. Install a vacuum gauge. c. Start engine and raise rpm to 1000 in NEUTRAL. ***Is the vacuum reading steady and above 14 in. HG (45.5 kPa)?***	Step 4.	Step 9.
4.	Allow the engine to idle. ***Does the scan tool indicate MAP sensor voltage less than 1 volt?***	Step 5.	Step 11.
5.	a. Ignition OFF. b. Disconnect MAP sensor harness connector. c. Connect a jumper wire from harness terminal "B" CKT 432 to harness terminal "C" CKT 416. d. Ignition ON, engine OFF. ***Does the scan tool indicate MAP sensor voltage greater than 4 volts?***	Step 10.	Step 6.
6.	a. Ignition OFF. b. Connect DVOM from harness terminal "C" CKT 416 to a known good ground. c. Ignition ON, engine OFF. ***Does the scan tool indicate MAP sensor voltage greater than 4 volts?***	Step 12.	Step 13.
7.	a. Switch CodeMate Tester to "Normal Mode." b. Ignition OFF. c. Disconnect MAP sensor harness connector. d. Connect a jumper wire from terminal "B" CKT 432 to harness terminal "C" CKT 416. e. Start engine and raise rpm to 1000 in NEUTRAL. f. Ignition ON, engine OFF. g. Switch CodeMate Tester to "Service Mode" and watch for a trouble code. ***Is trouble code 33 present?***	Step 11.	Step 8.

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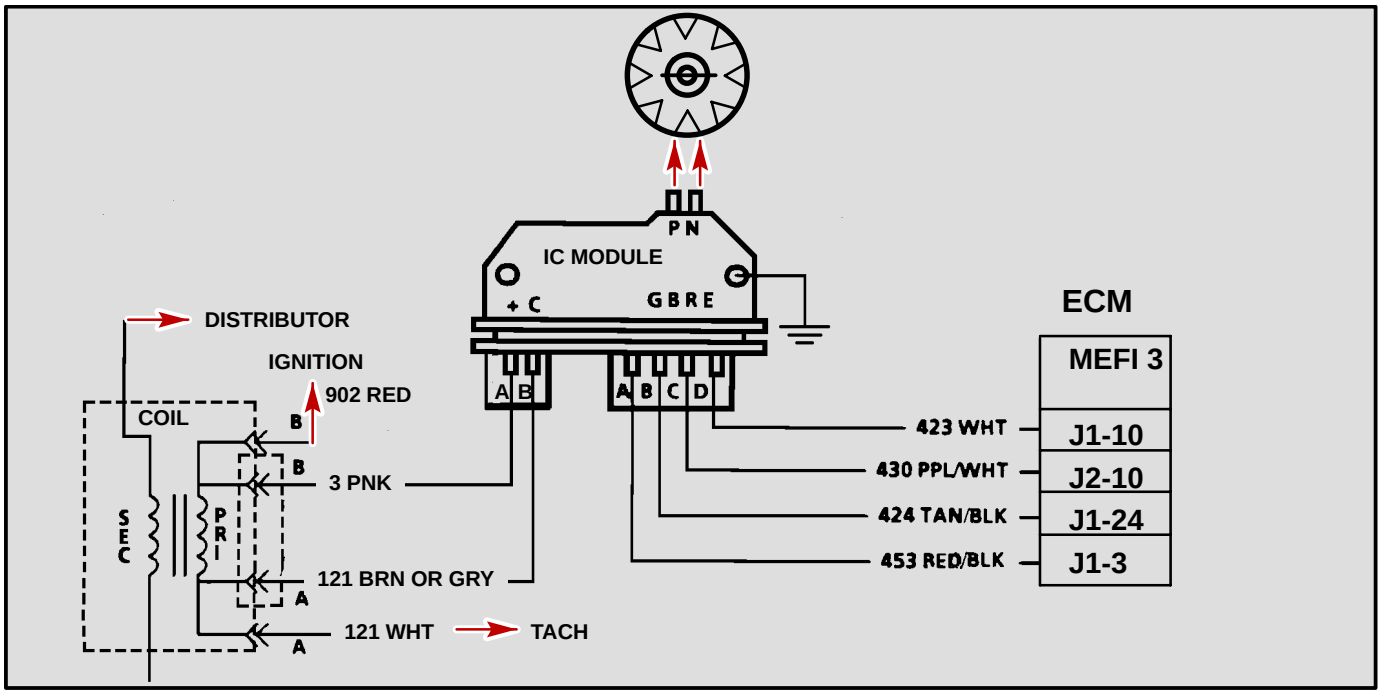
Code 34 (3 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
8.	a. Remove the jumper wire from CKT 416 and 432. b. Connect DVOM from harness terminal “A” CKT 814 to harness terminal “C” CKT 416. ***Is voltage reading above 4 volts?***	Step 12.	Step 13.
9.	Repair low or unsteady vacuum problem.	Verify Repair	–
10.	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor.		–
11.	Locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor.		–
12.	Locate and repair open or short to ground in CKT 432 or faulty ECM connections.		–
13.	Locate and repair open or short to ground in CKT 416 or faulty ECM connections. Also check CKT 416 to the TP sensor for a short to ground.		–

Code 41 (1 of 2): Ignition Control (IC) Circuit



CIRCUIT DESCRIPTION:

When the system is running on the ignition module or in crank mode, there is no voltage on CKT 424, and the ignition module grounds CKT 423. The ECM expects to detect a low voltage on CKT 423 during this condition. If the ECM sees voltage, it sets Code 41 and will not go into the Ignition Control (IC) mode.

When the rpm for IC is reached (about 300 rpm), and CKT 424 voltage applied, CKT 423 should no longer be grounded in the ignition module, and the voltage should be varying.

If CKT 424 is open or grounded, the ignition module will not switch to IC mode. The CKT 423 voltage will be low and Code 42 will be set.

If CKT 423 stays grounded, the IC module will switch to IC mode but, because the line is grounded, there will not be an IC signal and a trouble code 42 will be set.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTC and repair stalling condition.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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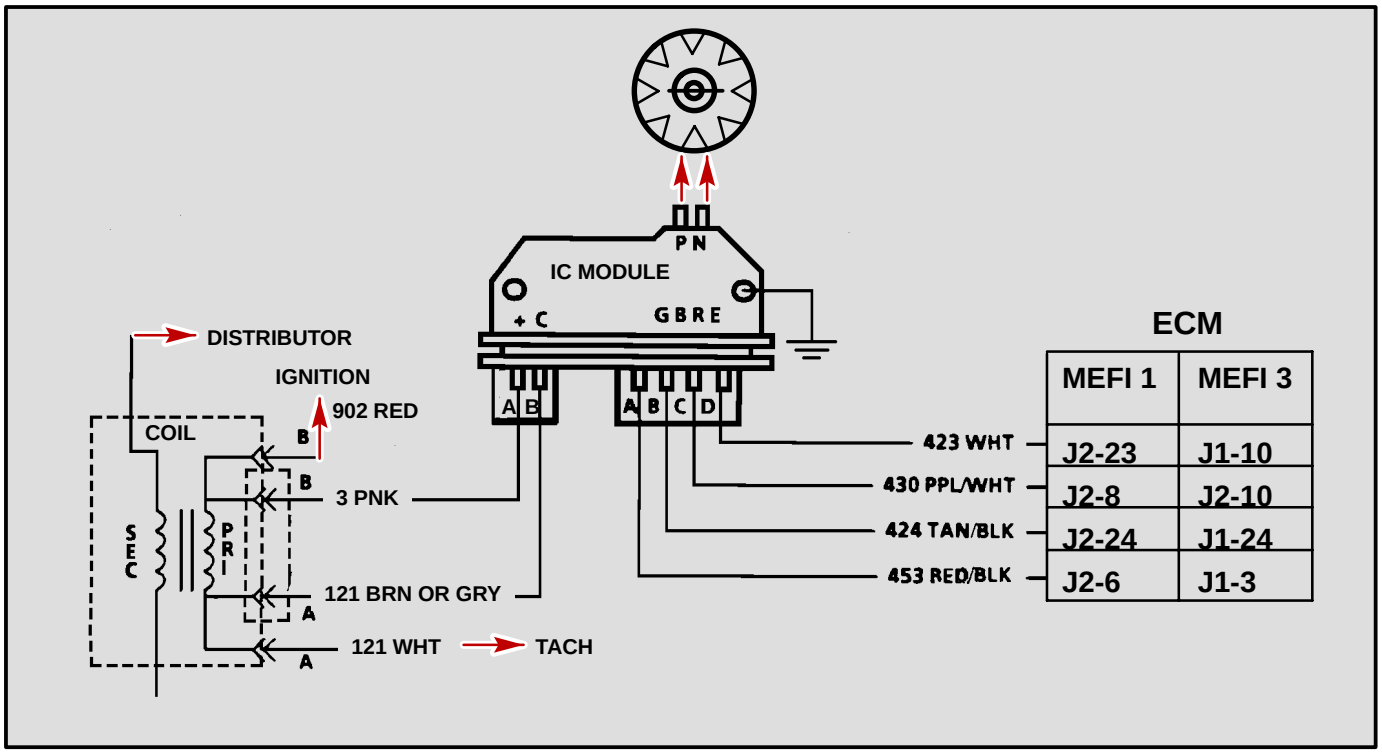
Code 41 (2 of 2): Ignition Control (IC) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Clear trouble code 41. b. Start engine and idle for 2 minutes or until trouble code 41 sets, whichever occurs first. ***Is trouble code 41 present?***	Step 3.	Step 7.
3.	a. Ignition OFF. b. Disconnect ECM harness connectors. c. Using a DVOM set on Ohms, probe ECM CKT 423 to ground. ***Is resistance above 3000 ohms?***	Step 4.	Step 5.
4.	a. Reconnect ECM. b. Start engine and idle for 2 minutes or until trouble code 41 sets, whichever occurs first. ***Is trouble code 41 present?***	Step 5.	Step 7.
5.	Locate and repair open in CKT 423 or faulty ECM connections. ***Was a problem found?***	Verify Repair	Step 6.
6.	Replace faulty distributor ignition module.		–
7.	Trouble code is intermittent. Refer to "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open in CKT 423.		–

Code 42 (1 of 3): Ignition Control (IC) Circuit



When the system is running on the ignition module or in crank mode, there is no voltage on CKT 424 and the ignition module grounds CKT 423. The ECM expects to detect a low voltage on CKT 423 during this condition. If the ECM sees voltage, it sets Code 41 and will not go into the Ignition Control (IC) mode.

When the rpm for IC is reached (about 300 rpm), and CKT 424 voltage applied, CKT 423 should no longer be grounded in the ignition module, and the voltage should be varying.

If CKT 424 is open or grounded, the ignition module will not switch to IC mode. The CKT 423 voltage will be low and Code 42 will be set.

If CKT 423 stays grounded, the IC module will switch to IC mode but, because the line is grounded, there will not be an IC signal and a trouble code 42 will be set.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTC and repair stalling condition.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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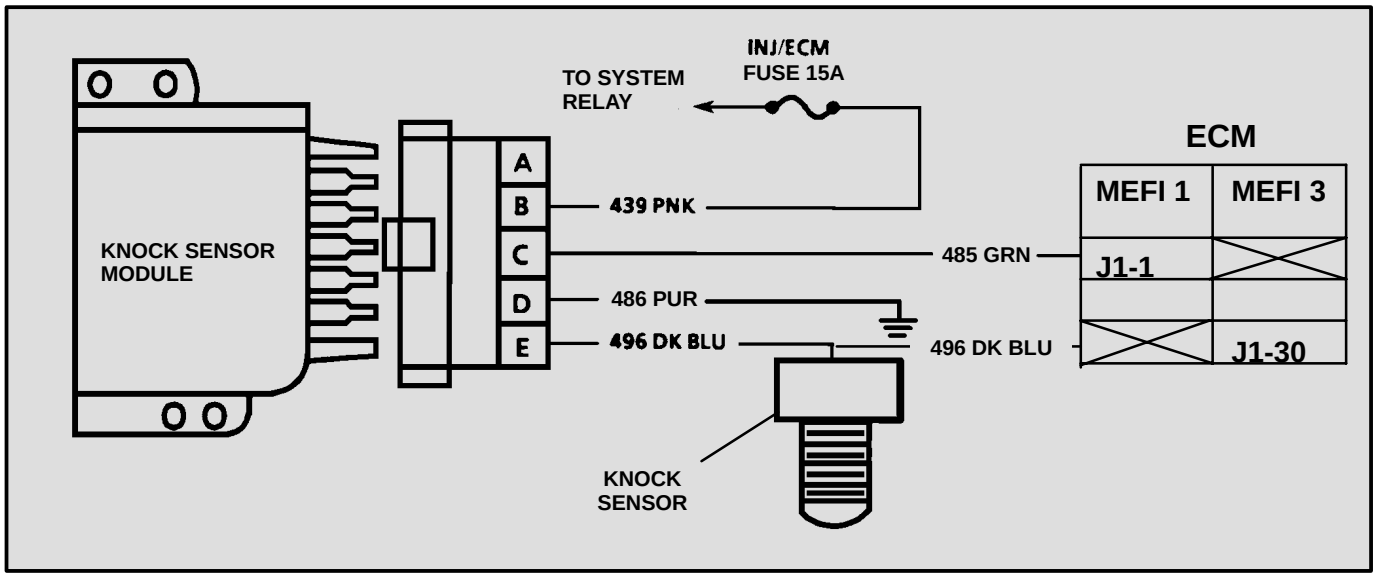
Code 42 (2 of 2): Ignition Control (IC) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Clear trouble code 42. b. Start engine and idle for 2 minutes or until trouble code 42 sets, whichever occurs first. ***Is trouble code 42 present?***	Step 3.	Step 11.
3.	a. Ignition OFF. b. Disconnect ECM harness connectors. c. Using a DVOM selected for Ohms, probe ECM harness terminal CKT 423 to ground. ***Is resistance over 3000 ohms?***	Step 4.	Step 7.
4.	a. Leave DVOM connected from ECM harness terminal CKT 423 to ground. b. Using a test light connected to battery positive (B+), probe ECM CKT 424. c. As the test light contacts CKT 424, the resistance should switch from over 3000 Ohms to under 1000 Ohms. ***Does the resistance switch to under 1000 ohms?***	Step 11.	Step 5.
5.	Using a test light connected to battery positive (B+), probe ECM CKT 424. ***Does test light illuminate?***	Step 6.	Step 8.
6.	Disconnect the ignition module 4-wire connector. ***Does the test light illuminate?***	Step 9.	Step 10.
7.	Locate and repair short to ground in CKT 423 or faulty ECM connections. ***Was a problem found?***	Verify Repair	Step 10.
8.	Locate and repair open in CKT 424. ***Was a problem found?***		Step 10.
9.	Locate and repair short to ground in CKT 424 or faulty ECM connections.		–
10.	Replace faulty ignition module.		–
11.	Trouble code 42 is intermittent. Refer To "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open or short to ground in CKT 424 or an intermittent short to ground in CKT 423.	–	–

Code 43 (1 of 3): Knock Sensor (KS) Circuit



CIRCUIT DESCRIPTION:

MEFI 1

Engine detonation or spark knock is sensed with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

MEFI 3

Engine detonation or spark knock is detected with a sensor that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage output level increases and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

NOTE: *MEFI 3 products do not have a knock module. The sensor connects directly to the ECM.*

DIAGNOSTIC AIDS

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false timing retard.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

NOTE: *If there are abnormal mechanical engine noises (rattles or knocks), they may give a false DTC 43. If fuel octane is too low, a false DTC 43 may be set.*

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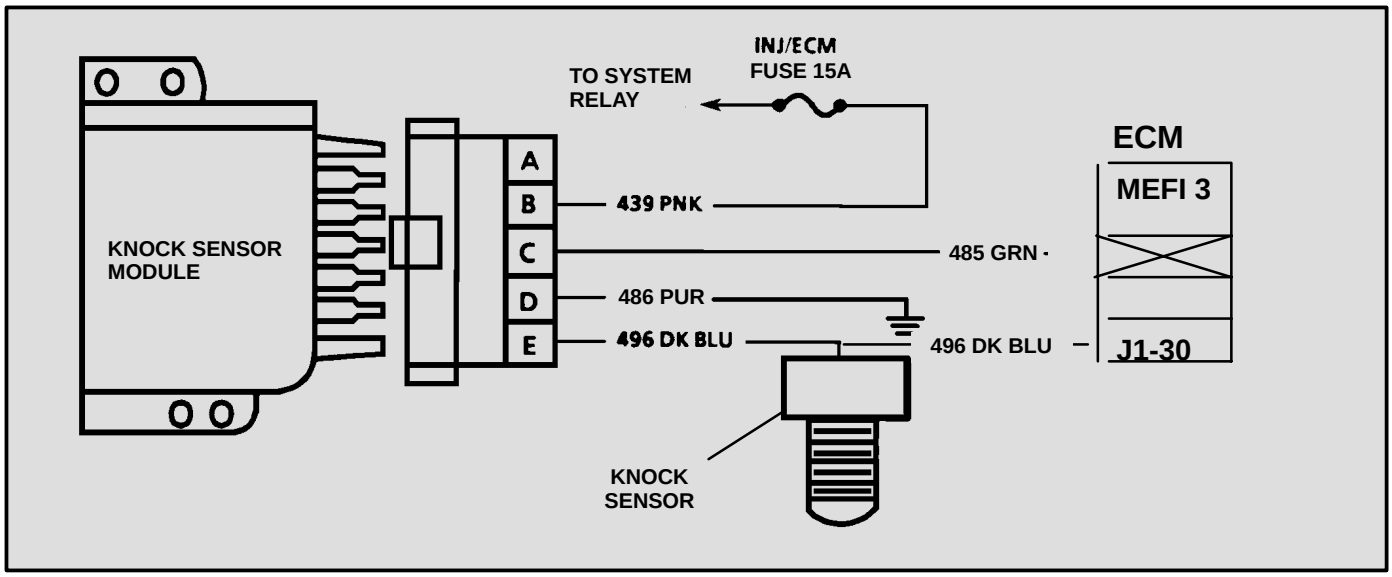
Code 43 (2 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Do you have a MEFI 3 ECM?***	Step 7.	Step 3.
3.	a. Disconnect 5-wire KS module connector b. Ignition ON, engine OFF. c. Using a test light connected to ground, probe KS module harness terminal "B" CKT 439. ***Does test light illuminate?***	Step 4.	Step 9.
4.	a. Using a test light connected to battery positive (B+), probe KS module harness terminal "D" CKT 486. ***Does test light illuminate?***	Step 5.	Step 10.
5.	a. Ignition OFF b. Reconnect KS module harness connector. c. Disconnect ECM J1 connector. d. Ignition ON, engine OFF. e. Connect DVOM from ECM CKT 485 to a known good ground. ***Is the voltage within 8-10 volts?***	Step 6.	Step 11.
6.	a. Allow DVOM voltage to stabilize. b. Connect a test light to battery positive (B+). c. Touch test light to CKT 496. ***Does voltage value change?***	Step 15.	Step 12.
7.	a. Disconnect ECM J1 connector b. Using DVOM, measure resistance between CKT 496 and ground. ***Is resistance between 3000 - 5000 ohms?***	Step 15.	Step 8.
8.	a. Disconnect KS connector. b. Using DVOM, measure resistance between KS and ground. ***Is resistance between 3000 - 5000 ohms?***	Step 12.	Step 14.
9.	Locate and repair open or short to ground in CKT 439.	Verify Repair	–
10.	Locate and repair open in CKT 486.		–
11.	a. Locate and repair open or short to ground in CKT 485. ***Was a problem found?***		Step 13.
12.	a. CKT 496 open or shorted to ground.		–

Code 43 (3 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
13.	Replace faulty KS module.	Verify Repair	–
14.	Replace faulty KS.		
15.	Trouble code 43 is intermittent. Refer To “Diagnostic Aids” on facing page.		–

Code 44 (1 of 3): Knock Sensor (KS) Circuit



CIRCUIT DESCRIPTION:

MEFI 1

Engine detonation or spark knock is sensed with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

MEFI 3

Engine detonation or spark knock is detected with a sensor that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage output level increases and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

NOTE: *MEFI 3 products do not have a knock module. The sensor connects directly to the ECM.*

DIAGNOSTIC AIDS

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false timing retard.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

NOTE: *if fuel octane is too high, a false DTC 44 may be set.*

Code 44 (2 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Do you have a MEFI 3 ECM?***	Step 7.	Step 3.
3.	a. Disconnect 5-wire KS module connector b. Ignition ON, engine OFF. c. Using a test light connected to ground, probe KS module harness terminal "B" CKT 439. ***Does test light illuminate?***	Step 4.	Step 9.
4.	a. Using a test light connected to battery positive (B+), probe KS module harness terminal "D" CKT 486. ***Does test light illuminate?***	Step 5.	Step 10.
5.	a. Ignition OFF b. Reconnect KS module harness connector. c. Disconnect ECM J1 connector. d. Ignition ON, engine OFF. e. Connect DVOM from ECM CKT 485 to a known good ground. ***Is the voltage within 8-10 volts?***	Step 6.	Step 11.
6.	a. Allow DVOM voltage to stabilize. b. Connect a test light to battery positive (B+). c. Touch test light to CKT 496. ***Does voltage value change?***	Step 15.	Step 12.
7.	a. Disconnect ECM J1 connector b. Using DVOM, measure resistance between CKT 496 and ground. ***Is resistance between 3000 - 5000 ohms?***	Step 15.	Step 8.
8.	a. Disconnect KS connector. b. Using DVOM, measure resistance between KS and ground. ***Is resistance between 3000 - 5000 ohms?***	Step 12.	Step 14.
9.	Locate and repair open or short to ground in CKT 439.	Verify Repair	–
10.	Locate and repair open in CKT 486.		–
11.	a. Locate and repair open or short to ground in CKT 485. ***Was a problem found?***		Step 13.
12.	a. CKT 496 open or shorted to ground.		–

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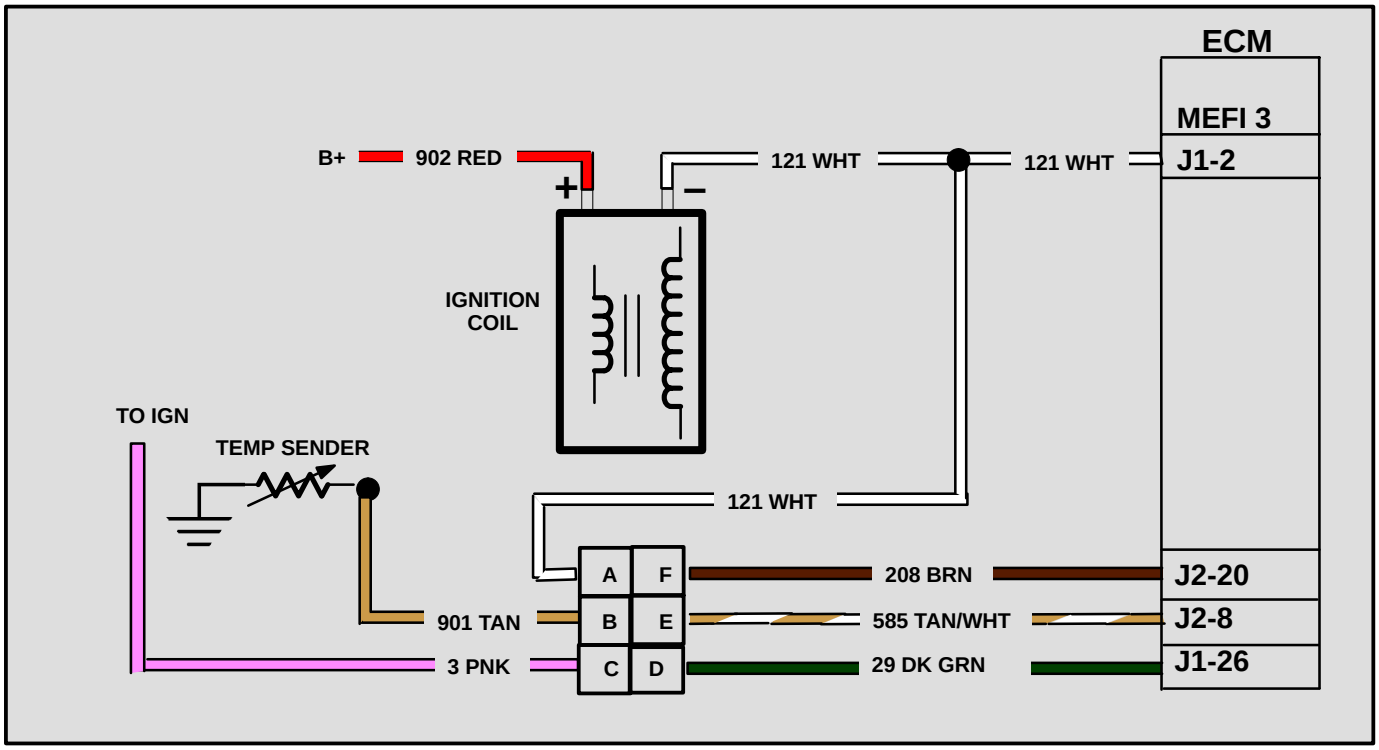
Code 44 (3 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
13.	Replace faulty KS module.	Verify Repair	–
14.	Replace faulty KS.		
15.	Trouble code 44 is intermittent. Refer To “Diagnostic Aids” on facing page.		

Code 45 (1 of 2): Ignition Coil Driver Fault



CIRCUIT DESCRIPTION:

On MEFI 3 product, the coil driver circuitry is integrated into the ECM. When the engine is running, a diagnostic check of the coil drive circuitry is constantly taking place. If the diagnostic system detects excessive current to the coil through CKT 121, a fault code will set although the engine should continue to operate.

DIAGNOSTIC AIDS

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Shorted CKT 121 or tach lead in harness.
- Damaged ignition coil or improper coil. The ignition system is calibrated for Mercury approved coils only.

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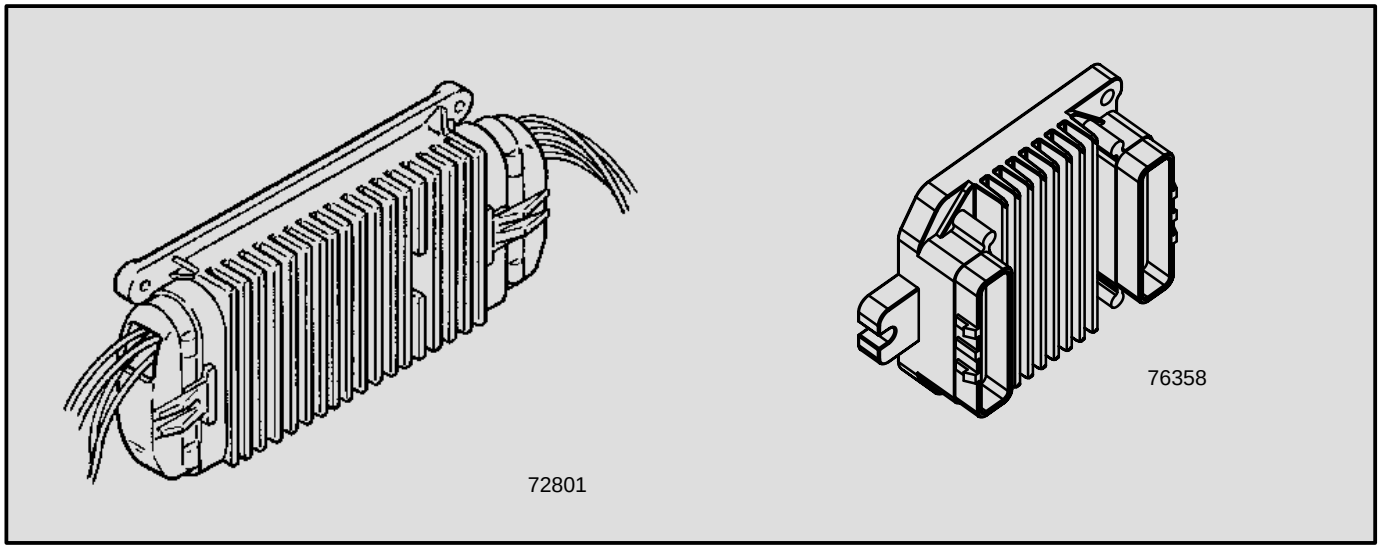
Code 45 (2 of 2):

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Ignition ON, engine OFF. b. Using DVOM, measure voltage at coil positive (+) terminal. ***Is Voltage Greater Than 12 Volts?***	Step 3.	Step 7.
3.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Check continuity from ECM CKT 121 to negative (–) terminal of coil. ***Is Resistance Less Than 1 ohm?***	Step 4.	Step 8.
4.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Check resistance from ECM CKT 121 to ground. ***Is Resistance Less Than 1 ohm?***	Step 9.	Step 5.
5.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Check resistance between positive (+) and negative (–) terminals of coil. ***Is Resistance Less Than 2 ohms?***	Step 6.	Step 10.
6.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Remove secondary ignition wire from coil. d. Measure resistance between secondary coil tower and negative terminal of coil. ***Is Resistance Greater Than 5 Ohms And Less Than 15 ohms?***	Step 11.	Step 10.
7.	Locate and repair open or short to ground in CKT 902.	Verify Repair	–
8.	Locate and repair open in CKT 121.		
9.	Locate and repair short to ground in CKT 121.		
10.	Replace ignition coil.		
11.	Trouble code 44 is intermittent. Check ignition wires and plugs.	–	

Code 51 (1 of 1): Calibration Memory Failure



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of EFI.

DIAGNOSTIC AIDS:

If DTC 51 failed more than once, but is intermittent, replace the ECM.

Step	Action	VALUE	YES	NO
			PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	–	Step 2.	OBD
2.	Ignition ON. Clear trouble code 51. ***Does Code 51 reset?***	–	Step 4.	Refer to Diagnostic Aids
3.	Fault is not present at this time.	–	Refer to Diagnostic Aids	
4.	Replace faulty ECM and verify trouble code 51 does not reset.	–	Verify Repair	- –

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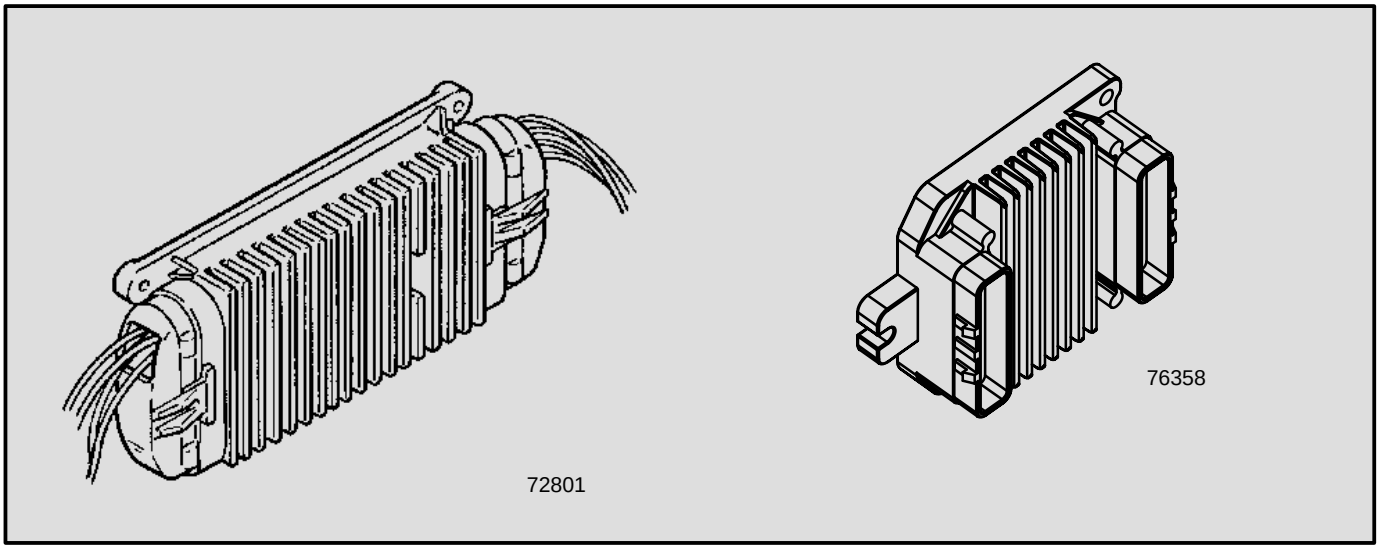
Code 52 (1 of 1): EEPROM Failure



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

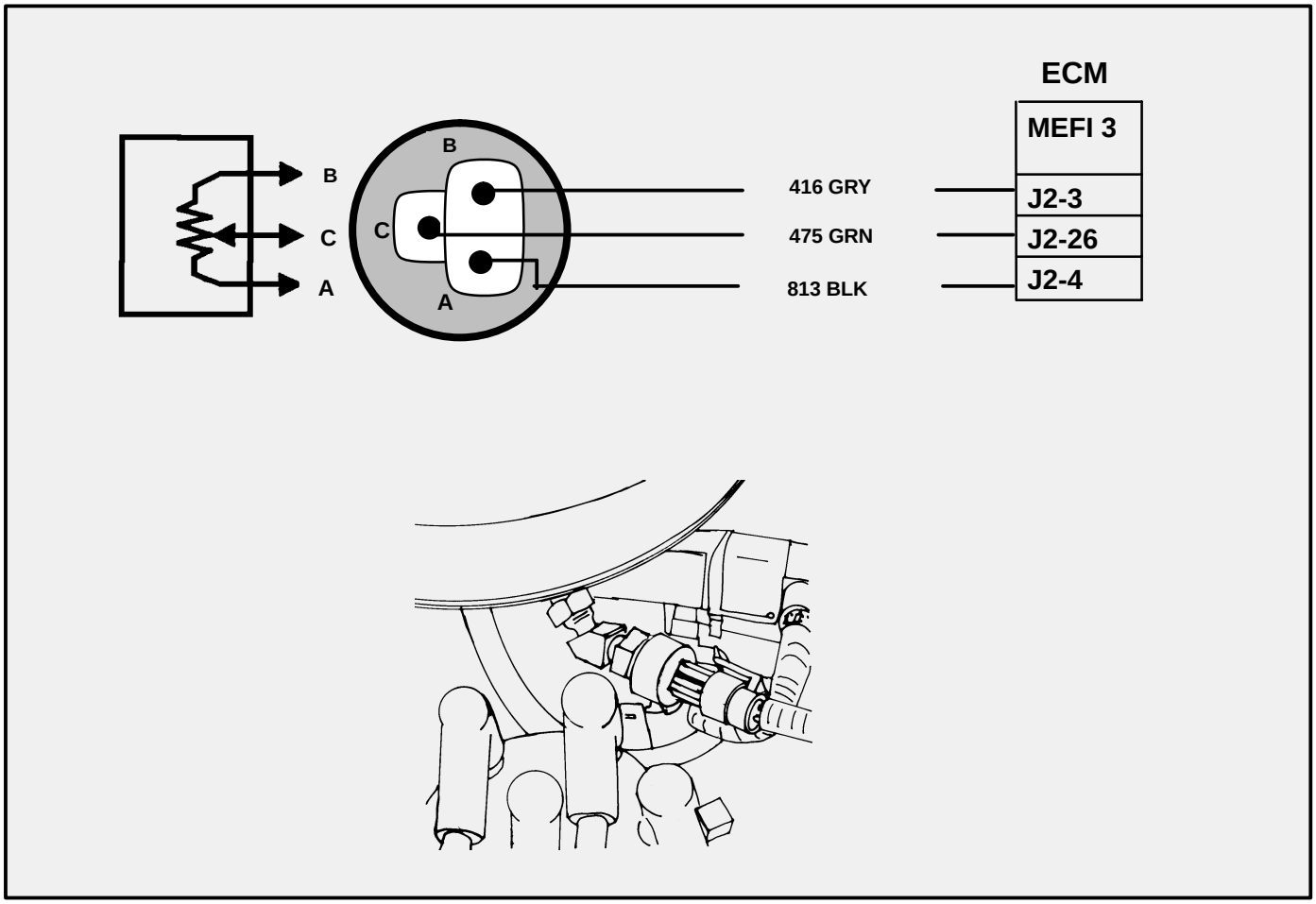
This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of EFI.

DIAGNOSTIC AIDS:

If DTC 52 failed more than once, but is intermittent, replace the ECM.

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	a. Clear trouble code 52. b. Ignition ON. ***Does trouble code 52 reset?***	Step 3.	Refer to Diag-nostic Aids
3.	Replace faulty ECM and verify trouble code 52 does not reset.	Verify Repair	–

Code 61 (1 of 2) Fuel Pressure (FP) Circuit



CIRCUIT DESCRIPTION:

The fuel pressure (FP) Sensor provides a voltage signal that changes with measured fuel pressure. Signal voltage should be between 2.5 and 3.5 volts.

The FP signal provides inputs to the Electronic Control Module (ECM) for fuel control.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage and test by moving the FP connector and harness.
- The scan tool reads fuel pressure in voltage relative to the pressure regulator setting. With ignition ON, engine OFF, the voltage should be 2.5-3.5 volts.
- If DTC 62 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

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Code 61 (2 of 3) Fuel Pressure (FP) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	a. Ignition ON. ***Does scan tool indicate fuel pressure sensor voltage greater than 4 volts?*** ***Does scan tool indicate fuel pressure sensor voltage less than .3 volts?***	Step 6. Step 5.	Step 4. Step 4.
4.	Code 61 is intermittent, refer to "Diagnostic Aids" on facing page.	–	–
5.	a. Ignition OFF. b. Disconnect fuel pressure sensor electrical connector. Jumper fuel pressure sensor harness terminals "B" and "C" together. c. Ignition ON. ***Does scan tool indicate fuel pressure sensor voltage greater than 4 volts?***	Step 15.	Step 7.
6.	a. Ignition OFF. b. Disconnect fuel pressure sensor connector. c. Ignition ON. ***Does scan tool indicate voltage over 4 volts?***	Step 13.	Step 7.
7.	a. Ignition ON. b. Connect DVOM from harness terminal "B" (5 volt reference to harness terminal "A" (sensor ground). ***Is voltage reading over 4 volts?***	Step 8.	Step 11.
8.	Connect DVOM from harness terminal "B" (CKT 416) to harness terminal "C" (fuel pressure sensor signal, CKT 475). ***Is voltage reading over 4 volts?***	Step 9.	Step 10.

Code 61 (3 of 3) Fuel Pressure (FP) Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	a. Ignition OFF. b. Connect a test light to battery positive (B+). c. Touch test light to harness terminal “C” (fuel pressure sensor signal). ***Is test light on?***	Step 12.	Step 15.
10.	Connect DVOM between harness terminal “C” and engine ground (–). ***Is voltage reading over 4 volts?***	Step 13.	Step 14.
11.	Connect DVOM from fuel pressure sensor harness terminal “B” to a good ground on engine. ***Is voltage reading over 4 volts?***	Step 18.	Step 17.
12.	a. Disconnect ECM. b. Touch test light to harness terminal “C” (fuel pressure sensor signal). ***Is test light on?***	Step 16.	Step 14.
13.	Check for CKT 475 shorted to voltage.	–	–
14.	Locate and repair open in CKT 475 or faulty connection at ECM.	–	–
15.	Replace fuel pressure sensor.	–	–
16.	Check for CKT 475 shorted to ground.	–	–
17.	CKT 416 open or shorted to ground or faulty connection at ECM.	–	–
18.	CKT 813 open or faulty connection at ECM.	–	–

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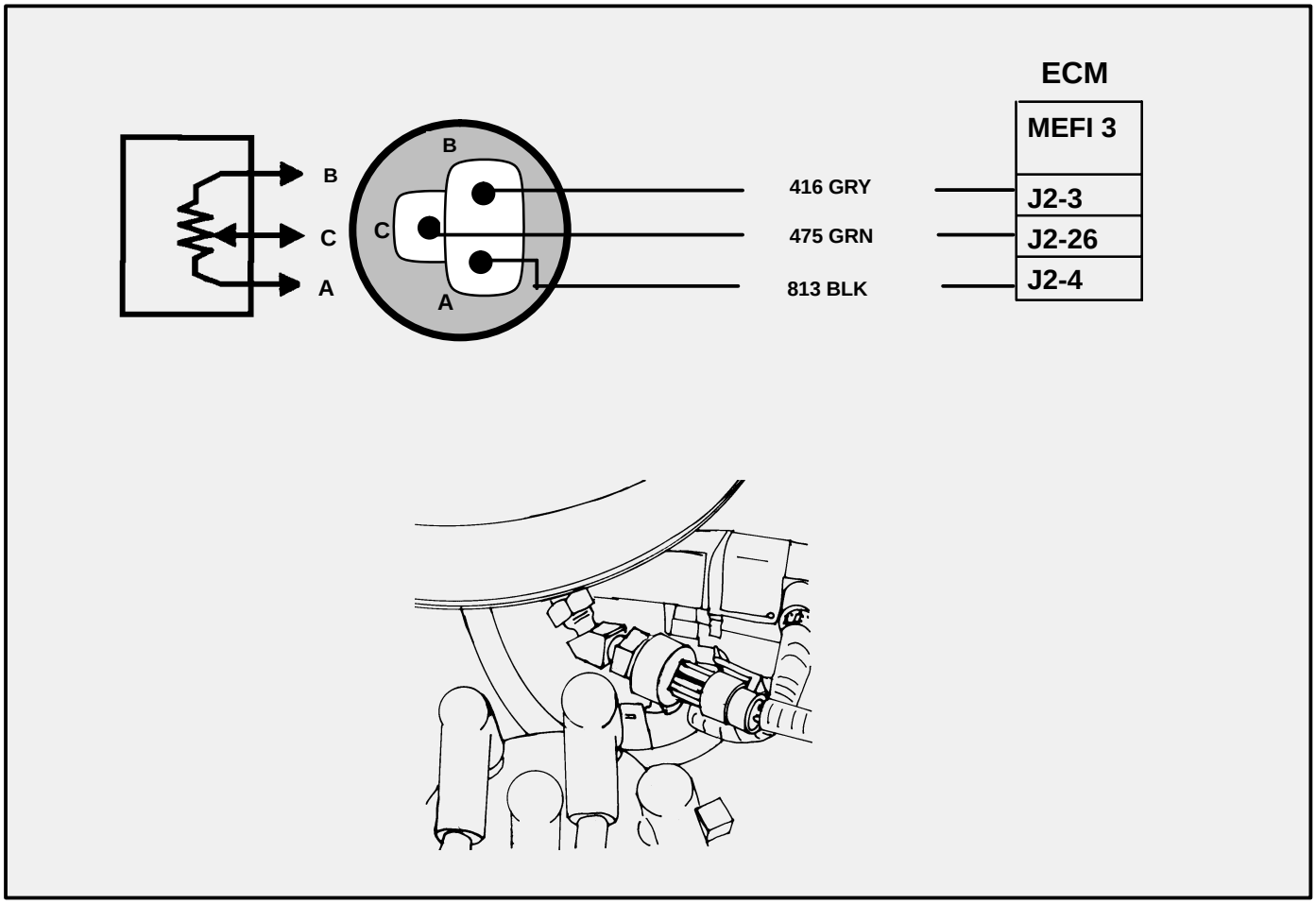
Code 62 (1 of 3) Fuel Pressure (FP) Sensor Circuit



CIRCUIT DESCRIPTION:

The fuel pressure (FP) Sensor provides a voltage signal that changes with measured fuel pressure. Signal voltage should be between 2.5 and 3.5 volts.

The FP signal provides inputs to the Electronic Control Module (ECM) for fuel control.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage and test by moving the FP connector and harness.
- The scan tool reads fuel pressure in voltage relative to the pressure regulator setting. With ignition ON, engine OFF, the voltage should be 2.5-3.5 volts.
- If DTC 61 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following “Clearing Trouble Codes” procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 62 (2 of 3) Fuel Pressure (FP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	***Was the "On-Board Diagnostic" (OBD) System Check Performed?***	Step 2.	OBD
2.	***Are you using a Scan Tool?***	Step 3.	Step 7.
3.	a. Ignition OFF. ***Does scan tool indicate fuel pressure sensor voltage less than .30 volt?***	Step 4.	Step 6.
4.	a. Ignition OFF b. Disconnect fuel pressure sensor harness connector. c. Connect a jumper wire from harness terminal "B" CKT 416 to harness terminal "C" CKT 475. d. Ignition ON, engine OFF. ***Does scan tool indicate fuel pressure sensor voltage greater than 4 volts?***	Step 9.	Step 5.
5.	a. Ignition OFF. b. Connect DVOM from harness terminal "B" (CKT 416) to a known good ground. ***Does DVOM indicate a voltage greater than 4 volts?***	Step 10.	Step 11.
6.	Trouble code 62 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."	–	–
7.	a. Switch CodeMate Tester to the normal mode. b. Ignition OFF. c. Disconnect fuel pressure sensor harness connector. d. Connect a jumper wire form harness terminal "B" CKT 416 to harness terminal "C" CKT 475. e. Start engine and idle for 2 minutes or until CodeMate Tester indicates a stored trouble code, whichever occurs first. f. Ignition ON, engine OFF. g. Switch CodeMate Tester to "Service Mode" and note trouble code. ***Is trouble code 61 present?***	Step 9.	Step 10.
8.	a. Remove jumper wire from CKT 416 and CKT 475. b. Connect DVOM from harness terminal "B" CKT 416 to harness terminal "A" CKT 813. ***Is voltage reading above 4 volts?***	Step 10.	Step 11.

Index

Code 62 (3 of 3) Fuel Pressure (FP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	Locate and repair intermittent faulty connections or replace faulty fuel pressure sensor.	Verify Repair	–
10.	Locate and repair open or short to ground in CKT 475 or faulty ECM connections.		–
11.	Locate and repair open or short to ground in CKT 416 or faulty ECM connections.		–

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COOLING SYSTEM

Section 6A - Seawater Cooled Models

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6 A

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Alternator Brace to Alternator	192		28
Alternator Mounting Bracket		30	41
Alternator Brace to Block			
Alternator/Power Steering Pump Mounting Bracket			
Power Steering Pump Bracket			
Seawater Pump Brace			
Seawater Pump Bracket To Block			
Seawater Pump Cover			
Thermostat Cover			
Thermostat Housing			
Thru-Hull Pickup Nut			
Alternator To Mounting Bracket		35	48
Water Circulating Pump			
Seawater Pump Clamping Screw On Casting Bracket		20	27
Water Temperature Sender			
Drain Plug (Note)	Securely		
Hose Clamps			
Petcocks			
Pulleys			

NOTE: *Coat threads with Quicksilver Perfect Seal before installing.*

Tools

Description	Part Number
Universal Puller Plate	91-37241
Quicksilver Flushing Attachment	44357A2

Special Tools

Description	Part Number
Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332	
Pulley Puller (Kent Moore)	J-25034-C

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Loctite 27131	92-809820
Quicksilver Perfect Seal	92-34227--1
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver High Performance Gear Lube	92-816026A2
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver Special Lubricant 101	92-13872A1
Silicone Sealant Or Equivalent	Obtain Locally
Shell Alvania No. 2 Grease	
Loctite Pipe Sealant with Teflon	
Marine Caulking	

Specifications

Cooling System Capacity	15 qts (14 l)
Thermostat	160° F (71° C)

Seawater Inlet Recommendations

Transom Mounted or Through The Hull Seawater Pickups and Hose

Water pickup must be large enough to permit sufficient water flow to engine seawater pickup pump for adequate engine cooling [30 gal/min (114 l/min) minimum]. Pickup also must supply a positive head while underway.

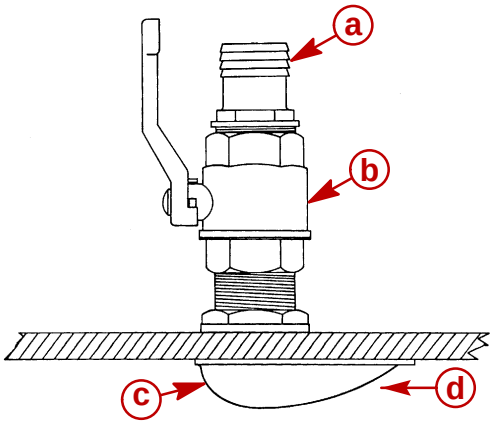
⚠ CAUTION

Do not install water pickup directly in line with propeller, as pickup may create turbulence and allow air to flow into the "propeller slipstream." This will cause propeller ventilation and will adversely affect boat performance.

Water pickup should be located as close to seawater pickup pump inlet as possible and in an area where an uninterrupted, solid stream of water will flow past when boat is underway. Connect water pickup to seawater pickup pump inlet with 1-1/4 in. (32 mm) I.D. wire reinforced hose of adequate wall thickness to prevent it from collapsing from pump suction. Be sure to secure hose connections with hose clamps.

Seacock (Seawater Inlet Valve)

If a seacock is being used, it must be installed between water pickup and seawater pickup pump (or sea strainer), to allow operator to shut off the seawater in case of a leak or when boat is not in use. This will allow the operator to flush or drain the engine, or clean the sea strainer while boat is in the water. Seacock used must have an internal cross-sectional area equal to or greater than hose to prevent restricting water flow. Install seacock in an area where it will be easily accessible and self-supporting to prevent hose fatigue.



70355

Seacock (With Through The Hull Pickup Shown)

- **a** - Hose Connector [1-1/4 in. (32mm) I.D.] to Seawater Pump Inlet
- **b** - Seacock [1-1/4 In. (32mm)] Brass Ball or Gate Valve
- **c** - Seawater Pickup
- **d** - Direction of Seawater Flow

Sea Strainer

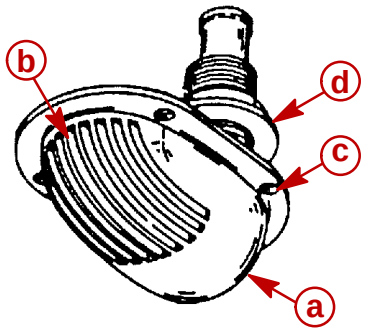
If boat is equipped with a sea strainer, it must be of sufficient size to ensure that an adequate supply of water is maintained for engine cooling. Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Strainer should be installed in water inlet hose after water inlet valve to allow operator to shut off water when cleaning strainer.

Seawater Pickups

NOTICE
Refer to manufacturer's instructions for information on removal and installation of other than Quicksilver Seawater Pickups.

IMPORTANT: Seal the inside edges of any hole made through the hull with a suitable sealant to prevent water absorption and deterioration.

Through The Hull Mounted



72639

a - Seawater Pickup
b - Seawater Inlet Slots
c - Mounting Screw Holes (If Equipped)
d - Nut

1. Seal inside edges of 1-3/4 in. (44 mm) hole in hull using a suitable sealer.
2. Apply marine caulking (sealer) to mounting surface on seawater pickup where hull contact will occur when installed.

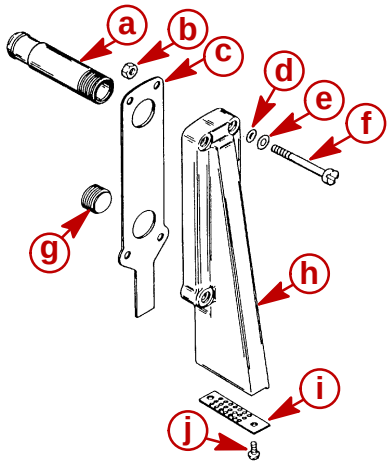
IMPORTANT: Seawater inlet slots must face forward - parallel with the flow of water.

3. Ensure slots in seawater pickup are facing forward (toward bow of boat) and install seawater pickup through hull.
4. Fasten pickup with four appropriate mounting screws (if equipped).
5. Apply marine caulking as needed inside boat. Apply Loctite 27131 to threads of nut and install on pickup on inside of boat and torque nut to 35 lb-ft (42 Nm).

NOTE: *If pickup being installed does not have mounting screws on underside where mounted to hull, be certain, after nut is torqued, that slots are still facing forward.*

Transom Mounted

(Quicksilver Part Number: 88845A1)



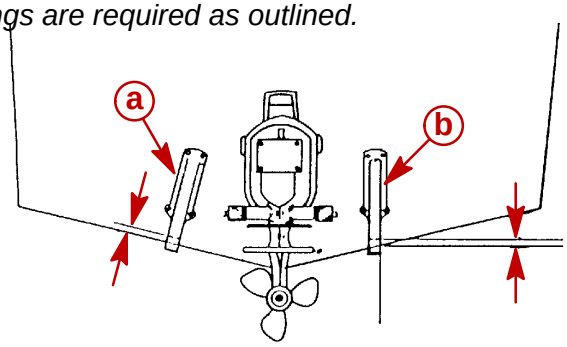
72640

Seawater Pickup Installation

- **a** - Hose Fitting
- **b** - Nuts (4)
- **c** - Gasket - Between Pickup and Transom
- **d** - O-Ring (4)
- **e** - Washer (4)
- **f** - Screw (4)
- **g** - Plastic Plug
- **h** - Pickup
- **i** - Screen
- **j** - Screw

1. Seal the inside edges of the 1-1/2 in. (38 mm) hole for hose fitting.
2. Be certain hose fitting and plastic plug are in place and threads have been sealed with Loctite Pipe Sealant with Teflon prior to tightening each securely.
3. Position one flat washer and one rubber O-ring on each 5/16 in. x 4 in. (102 mm) long, round head screw as shown. Coat each screw shaft with silicone sealant or equivalent.
4. Place new gasket on pickup housing and hold pickup in place on transom. Install four round head screws (with washers and O-rings in place) into pickup mounting holes and through drilled 21/64 in. (8.5 mm) holes in transom.

NOTE: *Some installations may have 7/32 in. (5.5 mm) holes drilled in transom using four 5/16 in. diameter stainless steel lag bolts in place of round head screws. In any case, flat washers and O-rings are required as outlined.*



72641

Water Pickup Installed on Transom

a - Diagonal Mount - Leading Edge of Pickup 1/8 in. (3mm) from Boat Bottom
b - Vertical Mount - Corner of Leading Edge of Pickup 1/8 in. (3mm) from Boat Bottom

5. Secure water pickup from inside with locknuts and washers (unless using lag bolts).
6. Tighten fasteners securely.

Quicksilver Sea Strainer

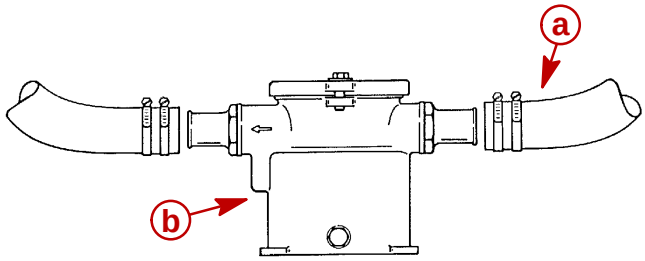
NOTICE
Refer to manufacturer's instructions for information on removal and installation of other than Quicksilver Sea Strainer

Removal

⚠ CAUTION
If boat is in water while working on seawater strainer, close seacock, if so equipped. If boat is not equipped with a seacock, remove and plug seawater inlet hose to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses and enter boat.

IMPORTANT: Be certain engine is off and cooling system is cold.

1. **Models Equipped with Seacock:**
   a. Close seacock (seawater inlet valve).
   b. Disconnect seawater inlet hose from seawater strainer.

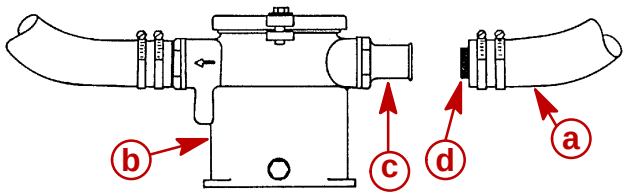


72691

a - Seawater Inlet Hose
b - Seawater Strainer

2. **Models without Seacock:**

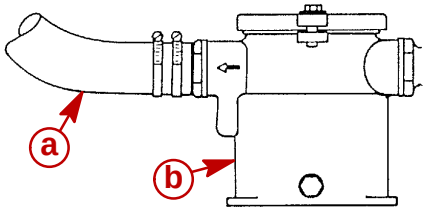
   a. Disconnect seawater inlet hose from seawater strainer inlet and plug seawater inlet hose.



70062

a - Seawater Inlet Hose
b - Seawater Strainer
c - Seawater Strainer Inlet
d - Plug

3. Remove outlet hose.
4. Drain into a suitable container.



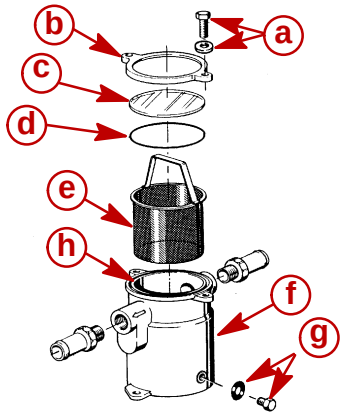
72643

a - Seawater Inlet Hose
b - Seawater Strainer

5. Remove mounting bolts.
6. Remove strainer.

Cleaning and Inspection

1. Remove and clean filter element.
2. Remove drain plug



72673

Quicksilver Seawater Strainer Shown

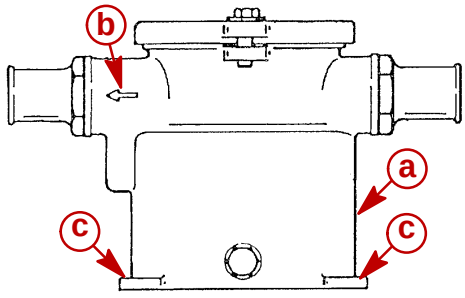
- **a** - Screws and Washers
- **b** - Cover
- **c** - Glass
- **d** - O-Ring
- **e** - Strainer
- **f** - Housing
- **g** - Drain Plug and Sealing Washer
- **h** - Gasket

3. Flush components with clean water.

Installation

IMPORTANT: Mount seawater strainer in a vibration-free location. Never mount it on the engine or transmission. Hoses must not be kinked or allowed to come in contact with hot or moving engine or transmission parts.

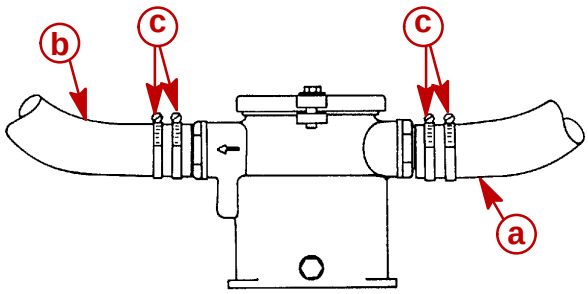
1. Mount seawater strainer. Arrow indicates required water flow direction and must point toward seawater pump. Tighten mounting bolts securely.



72644

- **a** - Seawater Strainer
- **b** - Arrow
- **c** - Mounting Bolt Hole Location (Bolts Not Shown)

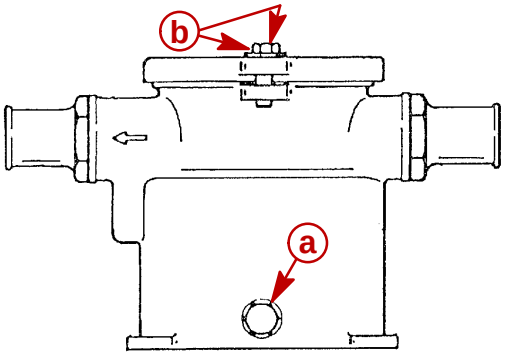
2. Remove plug from seawater inlet hose (if installed previously) and install hose on strainer. Install seawater outlet hose. Use two hose clamps on each hose connection. Tighten clamps securely.



72645

a - Seawater Inlet Hose
b - Seawater Outlet Hose
c - Double Hose Clamps

3. Check drain plug and lens cover bolts. Tighten securely. Do not overtighten cover bolts or cover may warp and leak water into boat.



72644

a - Drain Plug
b - Lens Cover Bolts (2, One Hidden In This View)

4. Open seacock, if equipped.

Seawater Pickup Pump

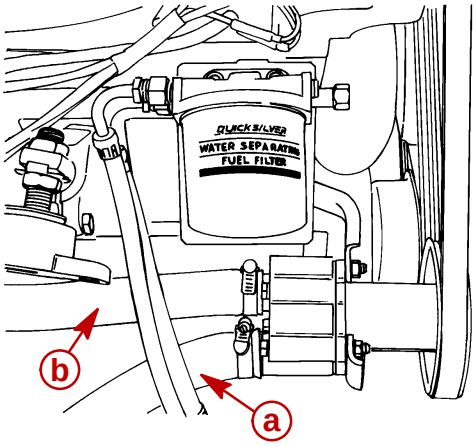
Output Test

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool the engine.

IMPORTANT: The following information should be observed before proceeding with test:

- **BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy with which it is performed. An error in setting the engine rpm, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within one second. An 8 U.S. qt. (7.6 l) or larger capacity container should be used to measure water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

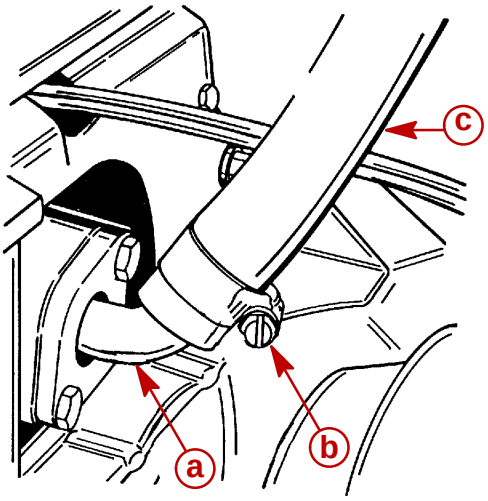
1. **Models With Engine Mounted Seawater Pump -** remove water hose, which runs between pump outlet and engine, and replace with another hose of same diameter, but approximately 3 ft (1 m) longer. Hose should be of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at pump outlet only. Do not clamp hose at engine end.



75533

a - Seawater Inlet Hose
b - Hose To Cooler

2. **Models With Sterndrive (Alpha) Mounted Seawater Pump -** remove water inlet hose, which runs between gimbal housing water tube and engine, and replace with another hose of same diameter, but approximately 3 ft (1 m) longer. Hose should be of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at gimbal housing water tube only. Do not clamp hose at engine end.



72614

a - Water Tube
b - Hose Clamp
c - Water Hose

3. Place an 8 U.S. qt. (7.6 l) or larger container near unclamped end of hose.
4. With assistance of another person, start engine and adjust speed to exactly 1000 rpm while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
5. Measure quantity of water discharged into container and compare with specifications given in the following chart.
6. Repeat test four times to check repeatability of results.

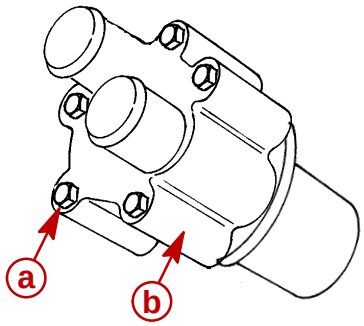
Engine Mounted Seawater Pump Output for a 15 Second Period
7.5 U.S. qt. (7.1 l) Minimum

Alpha Sterndrive Seawater Pump Output for a 15 Second Period	
Drive Unit Gear Ratio	**Minimum Quantity U.S. qts.(l)**
1.98:1	3.0 (2.8)
1.84:1	3.3 (3.1)
1.65:1	3.6 (3.4)
1.50:1	4.0 (3.8)
1.32:1	4.5 (4.3)

NOTE: *Refer to Alpha Sterndrive Service Manual for repair of seawater pump.*

Disassembly

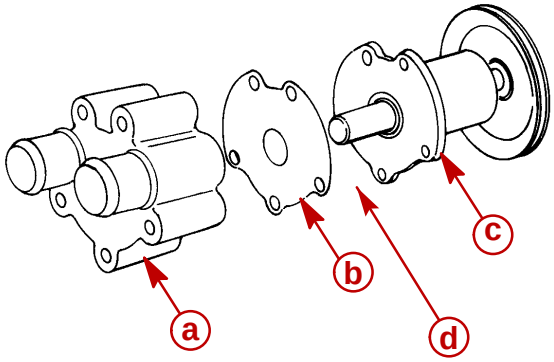
1. Remove the five screws from the seawater pump body.



75277

a - Screws (5)
b - Seawater Pump Body

2. Remove seawater pump body and wear plate from bearing housing.



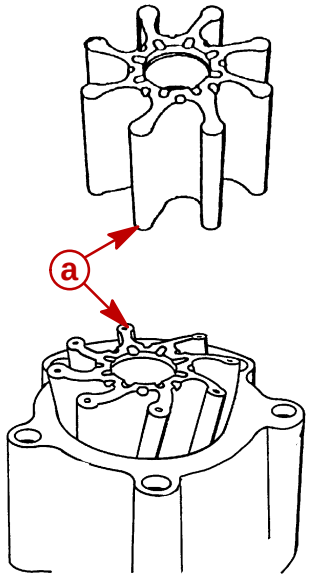
75275

a - Seawater Pump Body
b - Wear Plate
c - Bearing Housing

3. Remove the impeller from seawater pump body.

Reassembly

1. Lubricate seawater pump impeller with a water and soap solution. Install impeller into housing by rotating and pushing it into place. Push it down until flush with housing.

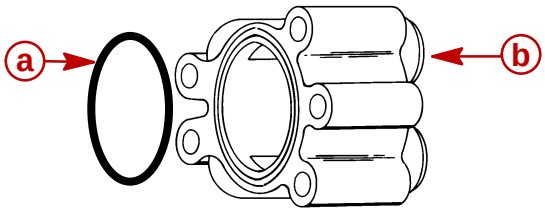


71118

71150

a - Impeller

2. Place wear plate over bearing housing shaft.
3. Place quad ring in groove in seawater pump body.

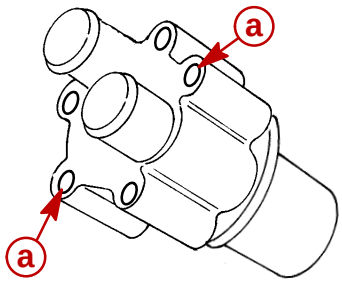


a - Quad Ring
b - Seawater Pump

4. Align flats on impeller and bearing housing shaft, slide seawater pump body on shaft.

NOTE: *Reassembly of the pump requires the mounting bracket to be installed while performing the following step.*

5. Install two screws in seawater pump body holes as shown. Use these two screws to align pump, then install the remaining screws.



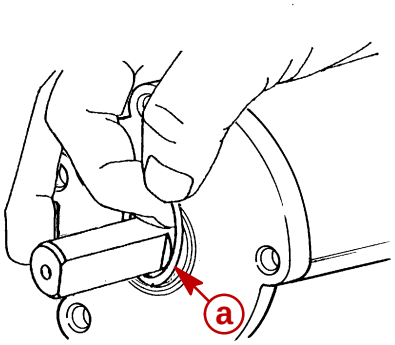
75277

a - Bolt Holes For Alignment

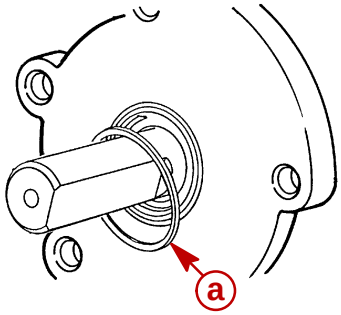
Seawater Pump Bearing Housing

Disassembly

1. Remove gasket, inner wear plate and quad ring seal. Discard gasket and quad ring seal.



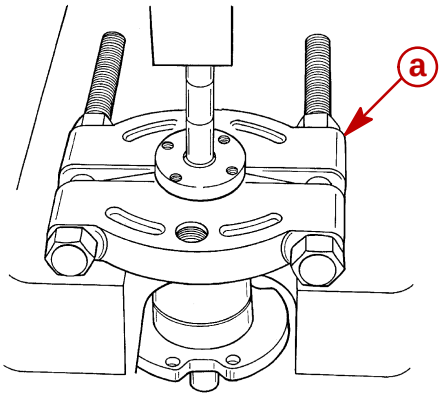
72655



72656

a - Quad Ring Seal

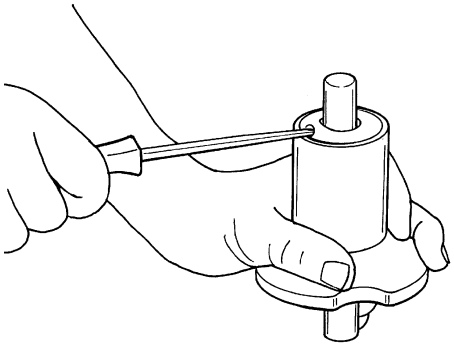
2. Press hub off shaft with Universal Puller Plate and an arbor press.



72648

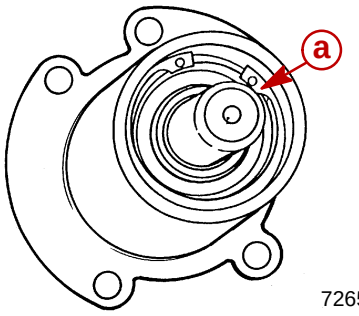
a - Universal Puller Plate (91-37241)

3. Puncture front oil seal with a tool and pry from bearing housing.

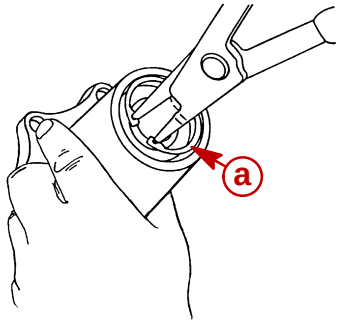


72649

4. Remove snap ring from bearing housing bore and press shaft and bearings out pulley end of housing. Bearings have a slip fit in housing; do not use excessive force.



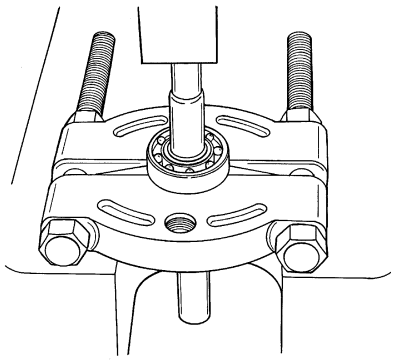
72657



72658

a - Snap Ring

5. If bearings require replacement, remove bearings from shaft with Universal Puller Plate and an arbor press. Bearings must be replaced, if removed.


72659

6. If rear seals require replacement, press seals from bearing housing with an appropriate tool.

Cleaning and Inspection

1. Clean metal parts in solvent and blow dry with compressed air.

IMPORTANT: Do not spin bearings at high speed when drying with compressed air, as bearings may be scored.

2. After cleaning, apply a coat of light engine oil to shaft and bearings to prevent rust.
3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Also inspect surface where bearings contact shaft for evidence of inner races turning on shaft.
8. Inspect pump body.
9. Inspect inner and outer wear plate.
10. Inspect pump impeller for wear on sides and tips of blades. Also inspect blades for cracks in area where blades flex. Replace impeller if blades have taken a set (remain in curved position).
11. Inspect pump pulley.
12. Check drive belt for excessive wear.

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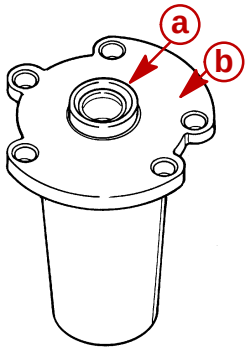
Reassembly

1. Apply a thin coat of Loctite 27131 to outside diameter of two new bearing housing rear seals; then install seals in housing with seal lips facing impeller end. Press first seal in until it bottoms out and second seal in until flush with housing.

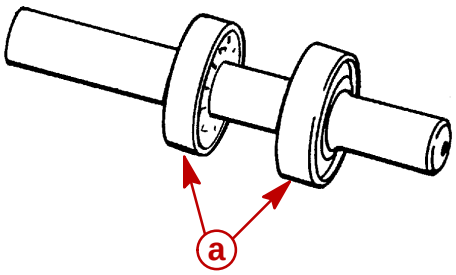


72660

a - Outer (Water) Seal
b - Face of Housing

IMPORTANT: It is recommended that Shell Alvania No. 2 Grease be used when packing seal and bearings in the following steps. If Shell Alvania No. 2 Grease is not available, it is permissible to use Quicksilver 2-4-C With Teflon. However, Quicksilver 2-4-C Marine Lubricant With Teflon is not recommended for applications where continuous high speed heavy-duty operation will be encountered.

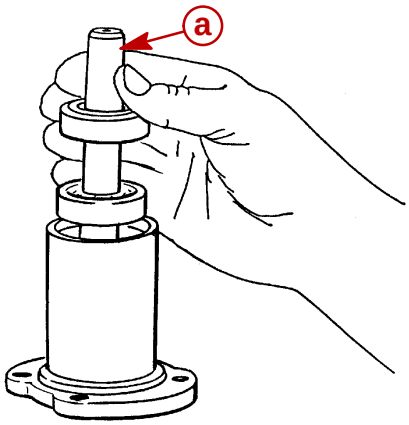
2. Pack cavity between seals with Shell Alvania No. 2 Grease or substitute.
3. Using an arbor press and suitable tool, press ball bearings onto shaft until they seat. Press on inner race of bearing only.



72663

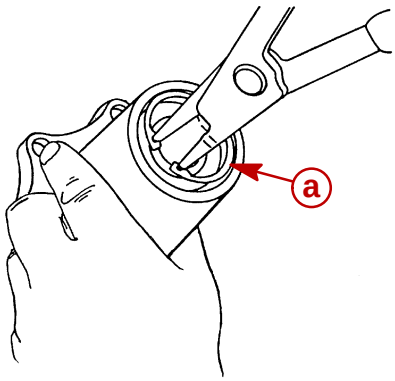
a - Bearings

4. Pack bearings and cavity between bearings with Shell Alvania No. 2 Grease or substitute. Slide bearings and shaft into bearing housing bore and install snap ring.



72661

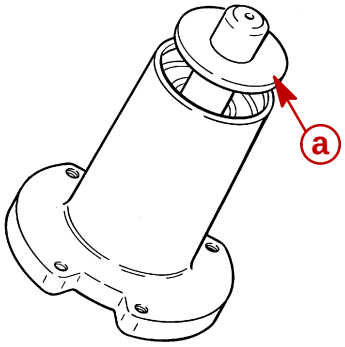
a - Shaft With Bearings



72658

a - Snap Ring

5. Apply a thin coat of Loctite 27131 to outside diameter of new bearing housing front oil seal and press seal into housing (with seal lip facing inward) until it bottoms out.

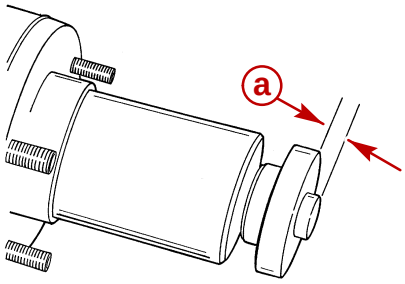


72662

a - Front Oil Seal

IMPORTANT: Be sure to support impeller end of pump shaft when installing pulley hub in next step to prevent placing a load on bearings.

6. Apply Quicksilver Special Lubricant 101 to pump shaft. Using an arbor press and appropriate tool, press pulley hub onto pump shaft to dimension shown.

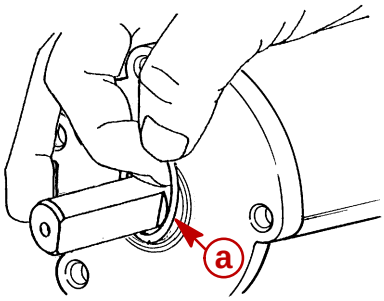


72664

a - .260 Inch (6.6 mm)

IMPORTANT: Pulley hub must be pressed onto shaft to exact dimension on pumps with stamped steel mounting bracket as this establishes proper drive belt alignment.

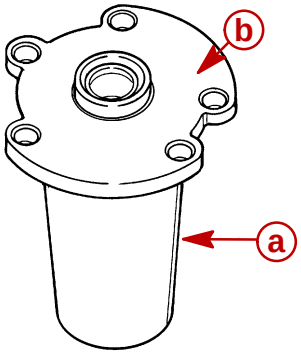
7. Clamp bearing housing in a soft jaw vise with flange end up.
8. Coat quad ring seal with Quicksilver 2-4-C Marine Lubricant With Teflon and install into groove in housing.



72655

a - Quad Ring Seal

9. Place the wear plate over the bearing housing.



72660

a - Bearing Housing
b - Wear Plate

Water Circulating Pump

Removal

1. Drain water from cylinder block.
2. Break loose circulating pump pulley attaching bolts. Do not remove bolts at this time.
3. Loosen alternator tensioner pulley, then pivot alternator inward and remove the serpentine drive belt.
4. Remove pump pulley attaching bolts, lockwashers, clamping ring (if equipped) and pulley.
5. Disconnect hose(s) from pump.
6. Remove bolts, which secure pump to cylinder block, and remove pump and old gaskets (discard gaskets).

Cleaning and Inspection

1. Clean gasket surfaces on water pump and cylinder block.
2. Inspect water pump for blockage, cracks, sand holes, corrosion or other damage. Inspect pump impeller for cracks and erosion. Replace complete pump if any damage exists.
3. Check impeller shaft and bearings for excessive side play. If play can be felt, replace complete pump.
4. Inspect pump pulley for bends, cracks, corrosion or other physical damage. Inspect pulley for rotational trueness. Replace pulley if damaged or untrue.

Installation

1. Coat both sides of new circulating pump gasket with Quicksilver Perfect Seal, then position gaskets and circulating pump on cylinder block. Coat threads of circulating pump attaching bolts with Quicksilver Perfect Seal and install bolts and alternator brace (if applicable). Torque bolts to specifications.
2. Reconnect hoses to pump.
3. Install pump pulley and clamping ring (if used) on pump hub and secure with bolts and lockwashers. Tighten bolts securely.
4. Install drive belts and adjust tension as outlined in “Drive Belt Tension Adjustment.”
5. Start engine and check for leaks.

Drive Belt Tension Adjustment

NOTICE
Refer to SECTION 1B - “Maintenance”

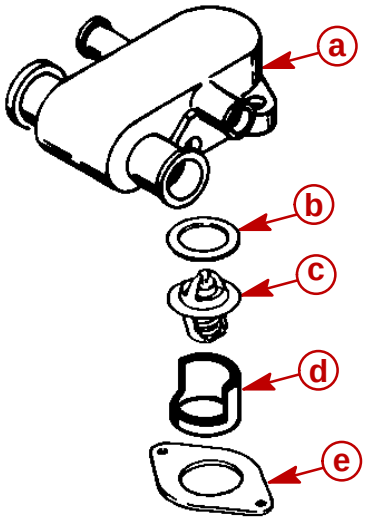
Flushing Seawater Cooling System

NOTICE
Refer to SECTION 1B - “Maintenance”

Thermostat

Removal

1. Drain water from cylinder block and exhaust manifolds.
2. Remove thermostat housing and related components.
3. Remove thermostat from thermostat housing or cover.

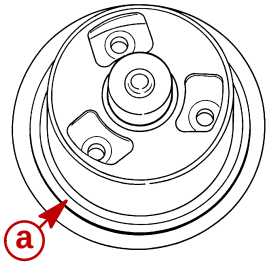


71758

a - Housing
b - O-Ring
c - Thermostat (Stainless Steel)
d - Spacer
e - Gasket

Testing

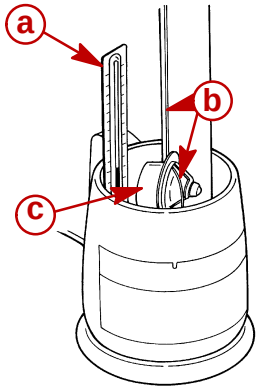
1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)



72717

a - Check For Light Leakage Around Perimeter Of Valve

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown) as follows:
   a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.
   b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.



72675

a - Thermometer
b - Nylon String
c - Thermostat

IMPORTANT: When performing procedures d. - f. water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at specified temperature stamped on thermostat.
   e. Continue to heat water until a temperature 25°F (14°C) above temperature specified on thermostat is obtained. Thermostat valve must be completely open at this temperature.

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f. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.

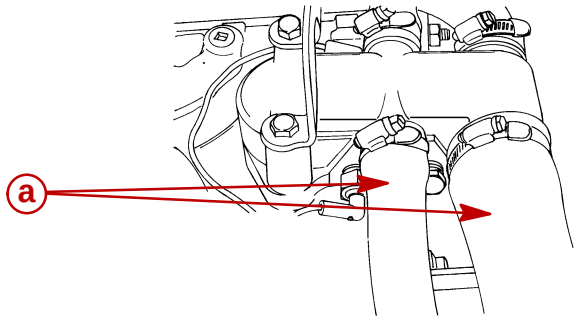
g. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Clean gasket surfaces on thermostat housing and intake manifold.

IMPORTANT: Gasket has continuity rivets. Do not coat with Quicksilver Perfect Seal, or Audio Warning Temperature Switch may not work properly.

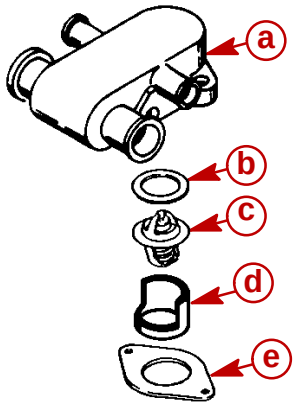
2. Place O-ring in the thermostat housing. Be certain it is positioned properly in housing.
3. Place thermostat in thermostat housing with thermostatic element end toward housing bottom, as shown.
4. Align sleeve with groove in thermostat housing bore and install sleeve into housing.
5. Coat both sides of new thermostat housing gasket with Quicksilver Perfect Seal and position on intake manifold.
6. Reinstall thermostat housing and torque screws with lockwashers to 30 lb-ft (41 Nm).
7. Reconnect hose(s) to thermostat housing. Tighten hose clamps securely.



75846

a - Hoses

8. Start engine and inspect for leaks.



71758

a - Housing
b - O-Ring
c - Thermostat (Stainless Steel)
d - Spacer
e - Gasket

Auxiliary Hot Water Heater Installation Information

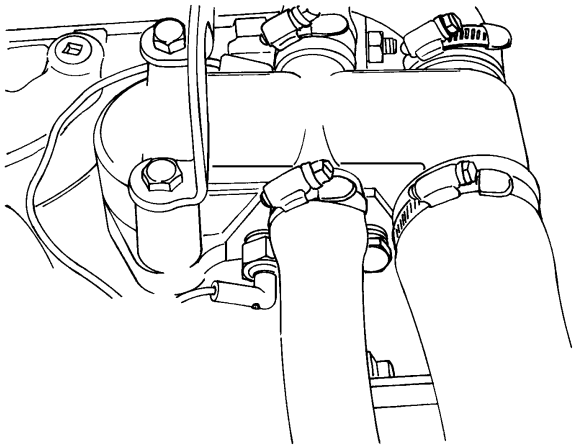
IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met.

- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (15.8 mm) I.D. (inside diameter).**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

1. Hot water heater supply hose can be connected at several different locations. On some models, there may be other accessories and options that are using these hot water supply locations. One of the following should be available for use when connecting the hot water heater system.

NOTE: *On some models it may be necessary to remove the audio warning heat switch from port side of thermostat housing and reposition to water circulating pump opening as outlined following.*

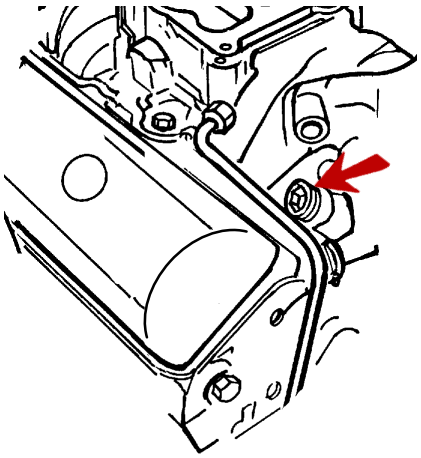
   a. Starboard side of thermostat housing, unless being used for engine temperature switch.



75846

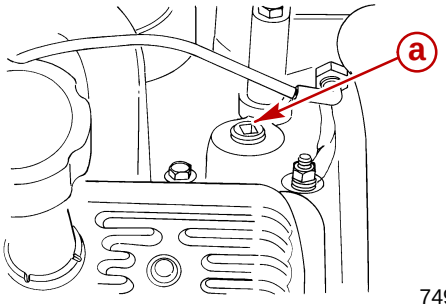
IMPORTANT: Do not reposition engine temperature switch, it must remain where installed by factory.

b. Intake manifold near thermostat housing (some models).



72708

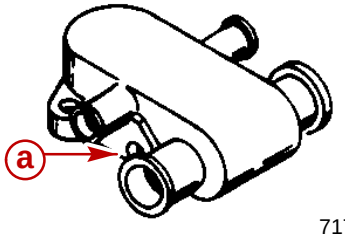
Intake Manifold (If Engine Temperature Sender is Not Installed at This Location)



74973

Engines with Raw Water Cooling - If Location is Available

a - Location for Hot Water Supply

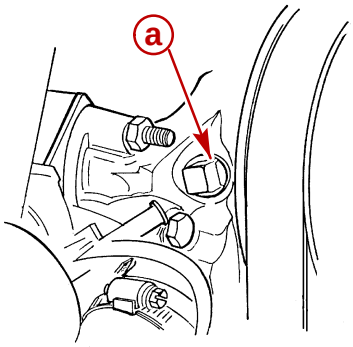


71758

Raw Water Cooling Models - Alternate Location

a - Location for Hot Water Supply (Install Bayonet Fitting Here)

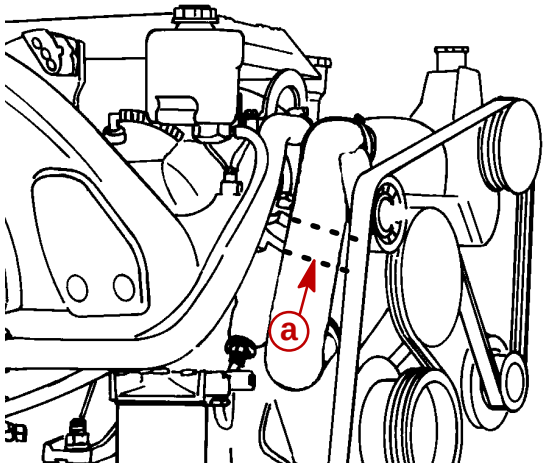
2. Connect hot water heater SUPPLY hose to desired location following instructions:
   a. Remove pipe plug.
   b. Coat threads of fitting(s) (obtained locally) with Quicksilver Perfect Seal and install fitting(s) in threaded hole from which pipe plug was removed.
   c. Connect hot water heat supply hose to fitting and secure with a hose clamp (not provided).



75480

a - Location for Hot Water Return

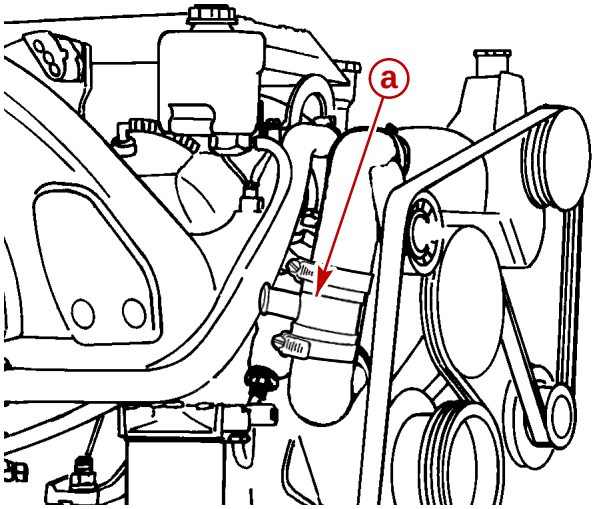
3. Connect hot water heater return hose into system as follows (refer to figures):
   a. Cut approximately 3/4 in. (19 mm) out of hose to maintain proper hose configuration.



72587

a - Cut Here

b. Secure T-fitting in hose with hose clamps (provided in kit) and tighten securely.



75859

Typical

a - T-Fitting

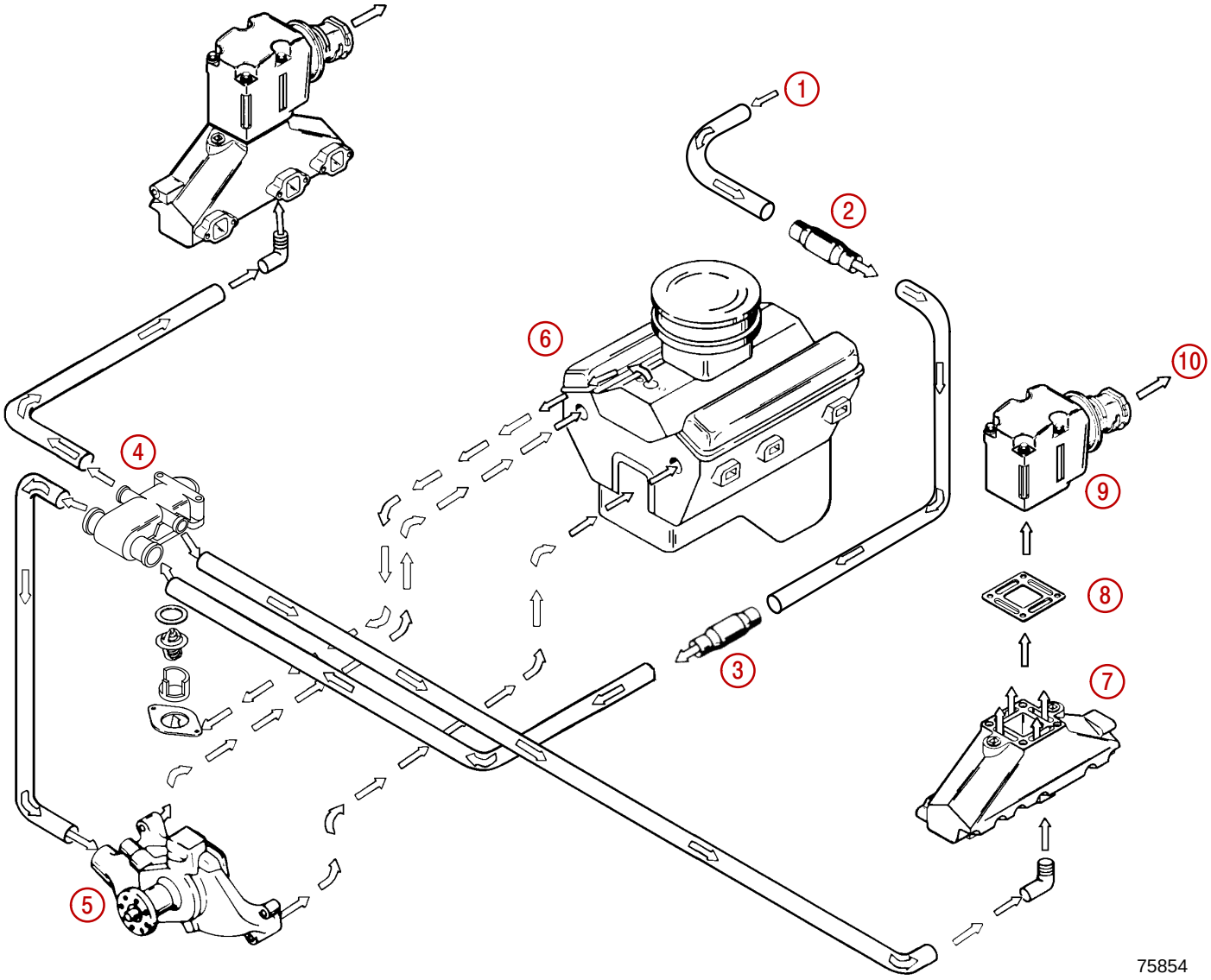
c. Connect hot water heater return hose to T-fitting and secure with hose clamp (provided).

4. Secure hoses, as required, to ensure they do not rub or chafe against engine components.
5. With boat in water, start engine and check for leaks and overheating.

Seawater Flow Diagrams

MCM 262 cid / 4.3L Alpha

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



75854

1 - Seawater Intake (From Sterndrive)
2 - Power Steering Cooler
3 - Fuel Cooler - EFI Models
4 - Thermostat Housing Assembly
5 - Engine Water Circulating Pump
6 - Engine Block and Cylinder Head Assembly
7 - Exhaust Manifold, Typical
8 - Gasket
9 - Exhaust Elbow Assembly, Typical
10 - Water Flow Overboard

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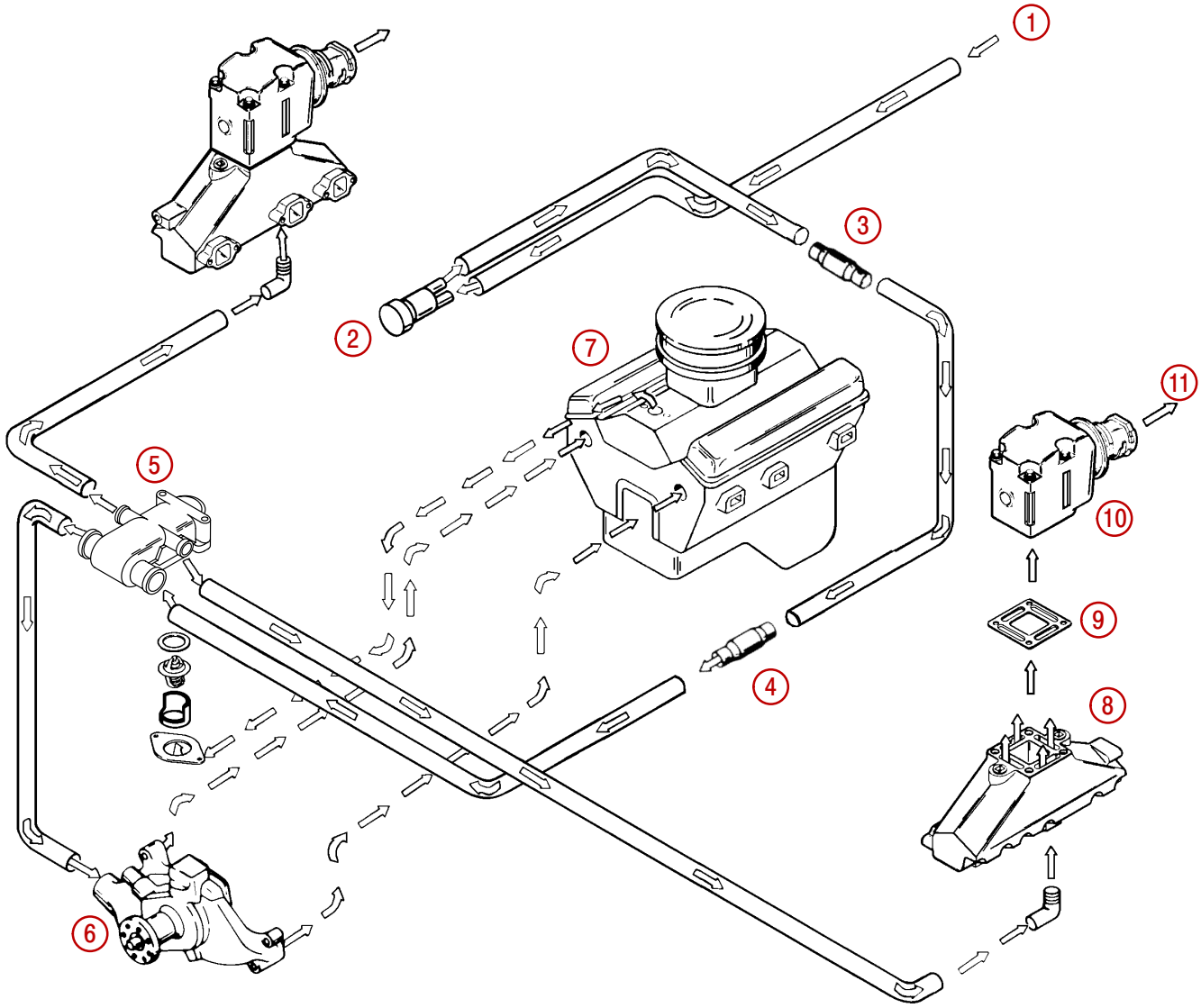
MCM 262 cid / 4.3L Bravo

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



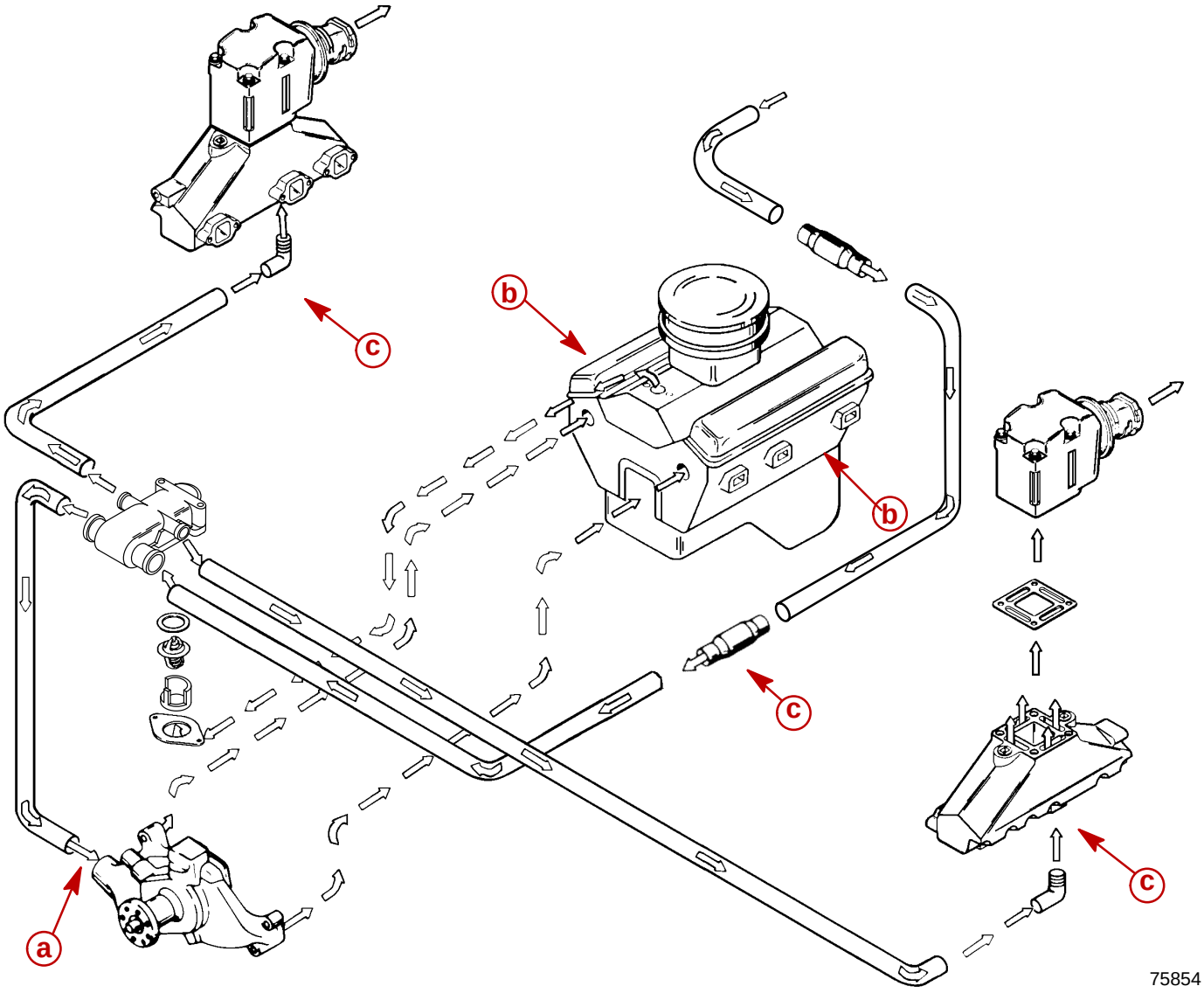
75861

1 - Seawater Intake(From Through The Hull or Through The Transom Pickup)
2 - Seawater Pump
3 - Power Steering Cooler
4 - Fuel Cooler EFI Models
5 - Thermostat Housing Assembly
6 - Engine Water Circulating Pump
7 - Engine Block and Cylinder Head Assembly
8 - Exhaust Manifold, Typical
9 - Gasket
10 - Exhaust Elbow Assembly, Typical
11 - Overboard (Water and Exhaust Discharge)

Draining Diagrams

MCM 262 cid / 4.3L Alpha

Two Piece Manifold, One Piece Similar



a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).
c - Remove Drain Plugs From Exhaust Exhaust Manifold Drain Elbows and Fuel Cooler or Water Tube (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained)

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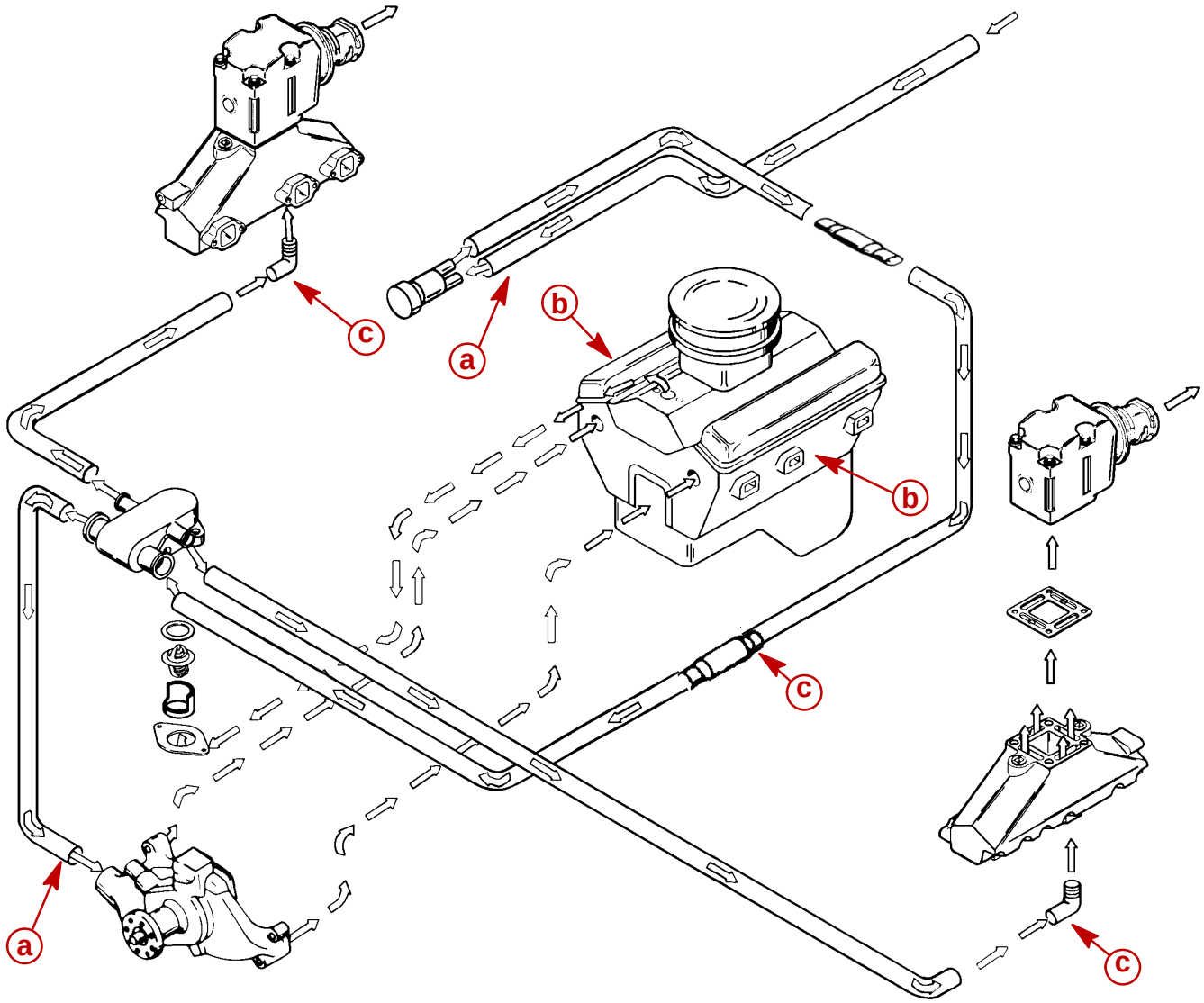
MCM 262 cid / 4.3L Bravo

Two Piece Manifold, One Piece Similar



74818

a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).
c - Remove Drain Plugs From Exhaust Exhaust Manifold Drain Elbows and Fuel Cooler or Water Tube (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained)

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COOLING SYSTEM

Section 6B - Closed Cooled Models

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6 B

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Heat Exchanger End Cap	36-72		4-8
Thermostat Cover		30	41
Heat Exchanger Mounting Brackets	Securely		
Hose Clamps			
Drain Plugs			

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Perfect Seal	92-34227--1
Quicksilver Liquid Neoprene	92-25711--3
Loctite Pipe Sealant With Teflon	Obtain Locally

Specifications

Closed Cooling System Capacity

NOTICE
Unit of Measurement: U.S. Quarts (Liters) **All Capacities are approximate fluid measures.**

Model	All Engines
Seawater Cooling System	15 (14.1)
Closed Cooling System	20 (19)

Coolant Specification

All Models
Extended Life Coolant 5/100 (Orange Color)

Thermostat

Engine	Specification
All Engines	160°F (71°C)

Pressure Cap Rating

Engine	Specifications
All Engines	16 psi (110 kPa)

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Description

The cooling system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat from the closed cooling system as it passes through the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint (230 mL) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there is a vacuum leak, usually at the hose leaving the reservoir or the gasket under the recovery filler cap.

IMPORTANT: The coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows through the inside of the cooling tubes in the heat exchanger.

Coolant Recommendations

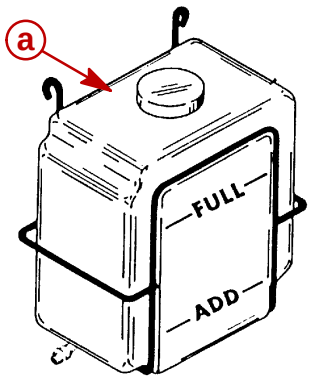
⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in fresh water section of cooling system at any time.

NOTE: *All factory installed closed cooling systems come filled with Extended Life Coolant. This antifreeze requires draining and replacing every five years or 1000 hours of operation, whichever comes first. For best results any "top-off" fluid used should be Extended Life Coolant. If Extended Life Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require the draining and replacing of the coolant every two years or 400 hours of operation, whichever comes first.*

In areas where the possibility of freezing DOES NOT exist, it is permissible to use solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Maintaining Coolant Level



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Coolant Recovery Bottle

a - Fill Cap

Before starting engine each day, ensure that coolant is visible in coolant recovery bottle.

If coolant is not visible, check fresh water section of cooling system (including coolant recovery system) for leaks and repair. Refill fresh water section with recommended coolant solution as outlined under “Changing Coolant,” following.

If coolant is visible, start engine and run until it reaches normal operating temperature, then recheck coolant level in coolant recovery bottle. Coolant level MUST be between the ADD and FULL marks (on front of bottle).

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and remove cap.

If level is low, remove fill cap from coolant recovery bottle and add required amount of coolant solution. Refer to “Coolant recommendations” in this section.

IMPORTANT: ALCOHOL OR METHANOL BASE ANTIFREEZE OR PLAIN WATER ARE NOT RECOMMENDED FOR USE IN COOLING SYSTEM AT ANY TIME. In areas where ethylene glycol is not available, and the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer’s recommendations).

Occasionally, ensure that coolant recovery system is functioning properly by removing pressure cap from heat exchanger and checking level. Coolant level should be up to bottom of heat exchanger filler neck. If low, examine entire fresh water section (especially coolant recovery system) for leaks and repair.

IMPORTANT: When reinstalling pressure cap, tighten it until it contacts on filler neck.

Pressure Cap Maintenance

Pressure cap should maintain pressure in fresh water section of closed cooling system at normal engine operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, cap should be cleaned, inspected and pressure tested periodically as follows:

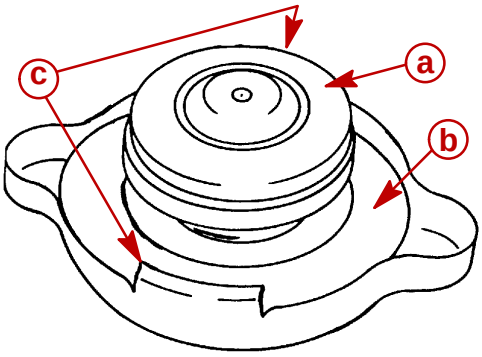
⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Remove pressure cap from heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect rubber seal on cap for cuts, cracks or other signs of deterioration. If seal is damaged, cap MUST be replaced.
4. Inspect coolant recovery gasket for deterioration and replace if bad.

5. Check condition of locking tabs on cap. Replace cap if tabs are bent or cracked.
6. Check gasket for cracks or other damage.

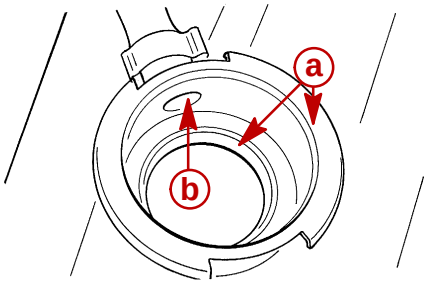
IMPORTANT: Cap MUST be replaced if damaged.



72714

a - Rubber Seal
b - Gasket
c - Locking Tabs (1 Hidden)

7. Test pressure cap. Refer to “Testing Pressure Cap.”
8. Clean sealing surfaces on heat exchanger filler neck with a cloth. Inspect surfaces for any damage or deposits that may prevent cap from sealing properly.
9. Clean coolant recovery passage in heat exchanger filler neck with a wire and blow out with compressed air.



72715

a - Sealing Surfaces
b - Coolant Recovery Passages

10. Reinstall pressure cap. Tighten cap until it contacts filler neck.

Heat Exchanger Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than three tubes.
2. Fittings and drains that have been broken off the heat exchanger can be reattached by brazing.

Testing Closed Cooling System

Testing Coolant for Alkalinity

⚠ WARNING

Allow engine to cool before removing pressure cap as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

Coolant in fresh water section should be changed per Maintenance Schedule recommendations and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. **If pink litmus paper turns blue,** coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink,** coolant is not alkaline and MUST BE REPLACED, as explained under “Changing Coolant.”

Pressure Testing System

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If coolant section of closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined in “Testing Pressure Cap.”
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also check locking cams on sides of filler neck to be sure that they are not bent or damaged.
4. Adjust coolant level in fresh water section to 1 in. (25 mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to amount specified in following chart.

Pressure Cap Rating	Amount of Pressure Applied to Closed Cooling System
16 psi (110 kPa)	20 psi (138 kPa)

6. Observe gauge reading for approximately two minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining specified pressure on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing.
8. Refer to “Testing Heat Exchanger” in this section and test as outlined.

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9. If no leakage could be found in above steps, engine is leaking internally. Leaking may be caused by one or more of the following:

- loose cylinder head bolts or damaged gasket,
- loose intake manifold bolts or damaged gasket,
- loose exhaust elbow or distribution block retaining nuts or damaged gasket,
- cracked or porous cylinder head or block, or
- cracked or porous exhaust manifold.

Proceed as follows until location of internal leak is found.

a. Start engine. Re-pressurize system to previously specified amount and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinders where leakage is taking place can sometimes be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.

b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug that is perfectly clean or milky appearing is a sure indication of a leak.

c. Drain oil from engine and examine for coolant. Oil will usually be milky if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, re-pressurize closed cooling section to previously specified amount and examine internal surfaces of engine to locate leak.

d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

Testing for Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (610-910 mm) long hose for this test.
2. Route this hose so a “U” is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (100-130 mm) of the “U.”
4. Observe the “U” while the engine is running.

a. **During Idle and Warm-Up:** Some coolant and/or air will leave the reservoir.

b. **During Cruising Speed (2500-3500 rpm):** Coolant and/or air leaving the reservoir should stop after approximately five minutes running at a given rpm. A leaking head gasket will produce air bubbling through the “U,” going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.

c. **At Higher Speeds (4000+ rpm):** Normal operation is the same as described in b. above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

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Do not confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant that will stop within approximately five minutes at a given rpm. A head gasket leak will not stop because the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant flows evenly from the reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

Testing Heat Exchanger

FOR INTERNAL LEAK: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed cooling circuit to 16-20 psi (110-138 kPa) with a radiator tester.
3. If seawater begins to flow from the nipple there is a leak.

FOR BLOCKAGE:

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.

1. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
2. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

Testing Pressure Cap

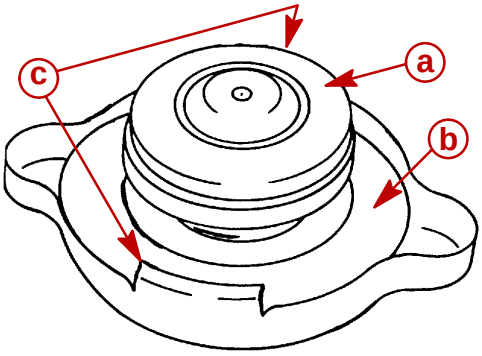
Pressure cap is designed to maintain a pressure of approximately its rated capacity (refer to “Specifications”) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure as follows:

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damaged, or entire cap if rubber seal is damaged.
4. Check condition of locking tabs on cap. Replace cap if tabs are bent or cracked.

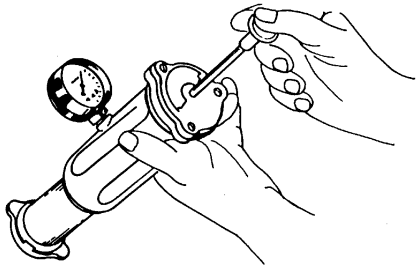
IMPORTANT: Cap MUST be replaced if damaged.



72714

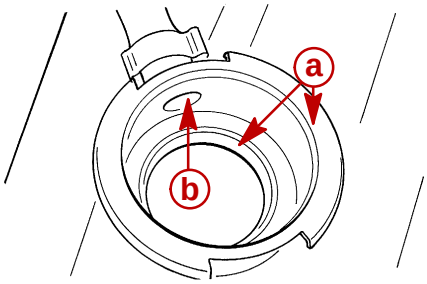
a - Rubber Seal
b - Gasket

5. Using a cooling system pressure tester (similar to one shown), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap must relieve pressure at 16 psi (110 kPa), and must hold rated pressure for 30 seconds without going below 11 psi. Replace cap if it fails to fall within these limits.



72716

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.



72715

a - Sealing Surfaces
b - Coolant Recovery Passages

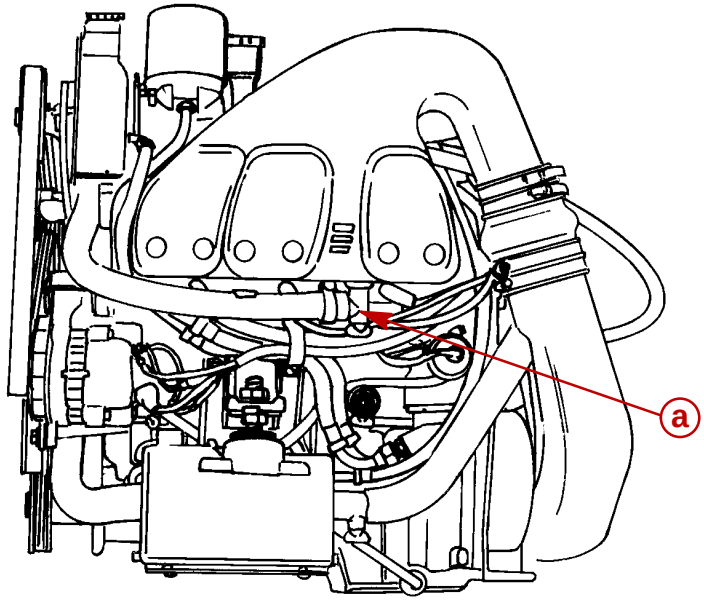
6. Reinstall cap on reservoir or heat exchanger.

Thermostat

Removal

NOTE: *If coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages. Remove fitting, if necessary, to insert wire completely into drain hole.*

1. Drain engine block by removing drain plugs. Be sure to drain port and starboard sides.

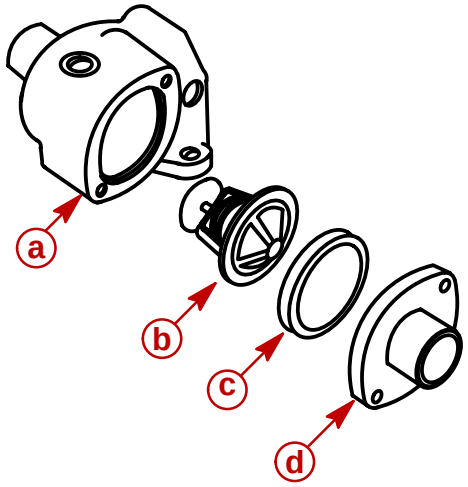


75052

Starboard Side Shown (Port Side Similar)

a - Hose

2. Disconnect hoses from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
4. Remove thermostat from thermostat housing.



75746

a - Thermostat Housing
b - Thermostat
c - Gasket
d - Thermostat Housing Cover

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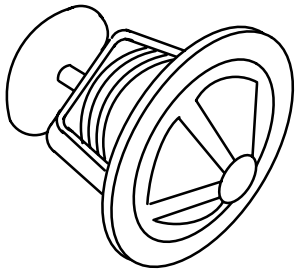
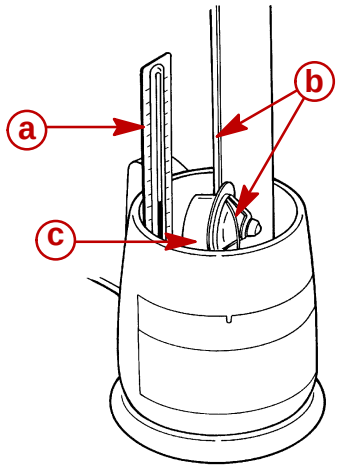
Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.



75747

3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)
4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:
   a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.
   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



72675

a - Thermometer
b - Nylon String
c - Thermostat (Typical)

   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

IMPORTANT: When performing instructions d. and e. water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread).
   e. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
   f. Replace a thermostat that fails to meet all of the preceding tests.

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Installation

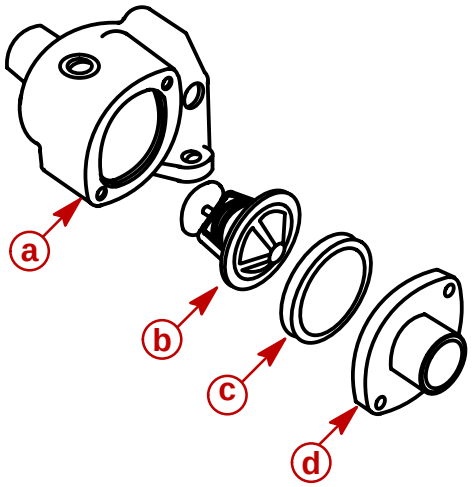
⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without cooling water being supplied to seawater pickup pump.

1. Remove thermostat housing and gaskets. Discard gaskets.
2. Clean gasket surfaces on thermostat cover, thermostat housing and intake manifold.
3. Position gasket on intake manifold. Place thermostat housing on gasket.

IMPORTANT: If gasket has continuity rivets, do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

4. Install thermostat, as previously shown, into thermostat housing.
5. Position gasket on thermostat and reinstall thermostat cover. Torque bolts to 30 lb-ft (41 Nm).



75746

a - Thermostat Housing
b - Thermostat
c - Gasket
d - Thermostat Housing Cover

6. Connect hoses to thermostat cover. Tighten hose clamps securely.
7. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Changing Coolant

NOTICE

For information and procedures on draining the seawater cooling system of Seawater Cooled (Rawwater) Models, refer to SECTION 6A. For information and procedures on draining the Seawater Section of Closed Cooling (Coolant) Models refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

Closed Cooling Section

Closed cooling section of closed cooling system should be kept filled year-round with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution, mixed to manufacturer's recommended proportions, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant using coolant specified in "Coolant Recommendations."

Change Intervals

If the closed cooling system is factory installed, drain and flush coolant from the closed cooling system at least every five years or 1000 hours of operation, whichever comes first. It should also be changed whenever exhaust gases have entered the system.

If the system is not factory installed or has had anti-freeze other than Extended Life Coolant added, it must be changed every two years or 400 hours of operation, whichever comes first.

Draining Instructions

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On some models with two piece petcock, removal of petcock may be required so that wire can be inserted completely into drain hole.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

IMPORTANT: Closed cooling section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, make sure closed cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

The following draining instructions apply to all engines equipped with closed cooling. The location of petcocks that require opening and hoses that require removal are represented on the following pages for the individual engines.

IMPORTANT: Observe precautions previously outlined before proceeding.

1. Remove pressure cap from coolant tank.
2. Drain coolant from locations as shown in the “Draining Diagram.”
3. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
4. Remove coolant recovery bottle from mounting bracket and pour out coolant.
5. Clean system as outlined in “Cleaning System.”
6. Fill system as outlined in “Filling Closed Cooling Section.”

Cleaning System

Closed Cooling Section

Closed cooling section of closed cooling system should be cleaned at least once every two years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Always follow manufacturer’s instructions for the cleaner.

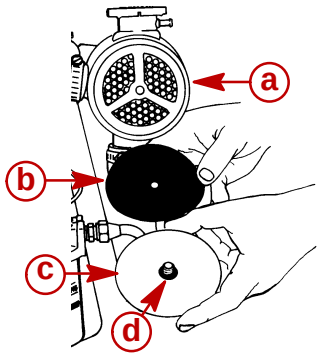
If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions that accompany flushing device for proper hookup and flushing procedure.

NOTICE
For information and procedures on draining and flushing Seawater Section of Closed Cooling (Coolant) Models, refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

Seawater Section

Cooling efficiency of an engine with closed cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc.) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned as specified in SECTION 1B "Scheduled Maintenance" or whenever decreased cooling efficiency is suspected.

1. Remove bolts securing end plates to heat exchanger.
2. Then remove end plates, seal washers and gaskets.
3. Discard seal washers and gaskets.
4. Clean gasket material from end plates and heat exchanger.



71515

a - Heat Exchanger
b - Sealing Washer
c - End Cap
d - Gasket

5. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
6. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets.
7. Reinstall end plates, using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.)
8. Torque end plate bolts to specifications.

⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without water being supplied to seawater pickup pump.

9. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Filling Closed Cooling Section

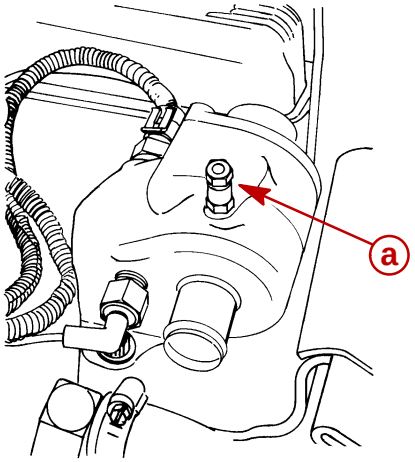
⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in coolant section of Closed Cooling System at any time.

It is recommended that coolant section of Closed Cooling System be filled with a 50/50 mixture of Extended Life Coolant and pure, soft water. This coolant MUST BE used regardless of whether freezing temperatures are expected to provide adequate corrosion protection. In areas where Extended Life Coolant is not available and the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

NOTE: *See SECTION 1B for coolant section capacity.*

1. Fill coolant section of Closed Cooling System with coolant mixture as follows:
   a. Open bleeder valve on thermostat housing.



75598

a - Hex Head Bleeder Valve

   b. Fill with coolant mixture through heat exchanger fill neck until coolant appears at bleeder valve opening.
   c. Close bleeder valve securely.
   d. Continue filling until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.

⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without water being supplied to seawater pickup pump.

⚠ CAUTION

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.

IMPORTANT: Coolant flows rapidly. Higher idle speeds increase dispersion of trapped air into system making it more difficult to purge trapped air. Operate at idle during filling and air purging when specified.

2. Start engine and run at IDLE.

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3. Add coolant solution to heat exchanger, as required, to maintain coolant level at filler neck.
4. After engine has reached normal operating temperature thermostat is fully open and coolant level remains constant, fill heat exchanger until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.
5. Remove cap from coolant recovery reservoir and fill to FULL mark with coolant solution.
6. Reinstall cap.
7. Lift recovery bottle and plastic tubing *above* heat exchanger filler neck. Allow coolant to flow down through tubing to purge air through filler neck fitting.
8. Install pressure cap on heat exchanger.
9. With engine still running, check hose connections, fittings and gaskets for leaks. Also observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.

⚠ WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4-turn to allow any pressure to escape slowly, then push down and remove cap.

10. Recheck coolant level after first boat test and add coolant, if necessary.
11. Maintain coolant level in coolant recovery reservoir between ADD and FULL marks with engine at normal operating temperature.

Coolant section of Closed Cooling System should be kept filled year around with recommended coolant solution. DO NOT drain coolant from fresh water section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that coolant section is filled with Extended Life Coolant and water solution, mixed to manufacturer's recommended proportion, to protect engine to lowest temperature to which it will be exposed.

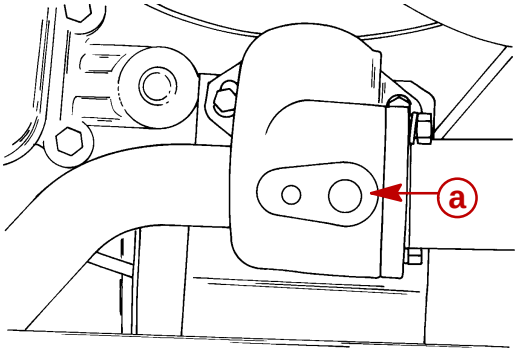
Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met:

- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (16 mm) I.D. (inside diameter).**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

⚠ CAUTION

On closed cooling models, the heater must be mounted lower than the fill cap on the heat exchanger. If the heater is higher than the fill cap on the heat exchanger and some coolant is lost from system, an air pocket may form in the closed cooling system. This can cause the engine to overheat.



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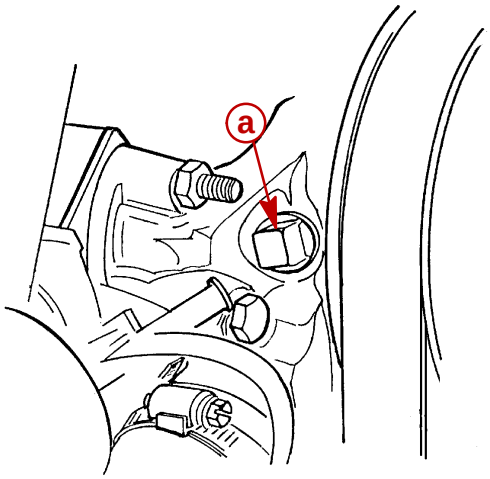
Supply Hose Connection

a - Location For Hot Water Supply Hose (Thermostat Housing As Viewed From Above)



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Return Hose Connection

a - Location For Hot Water Return Hose

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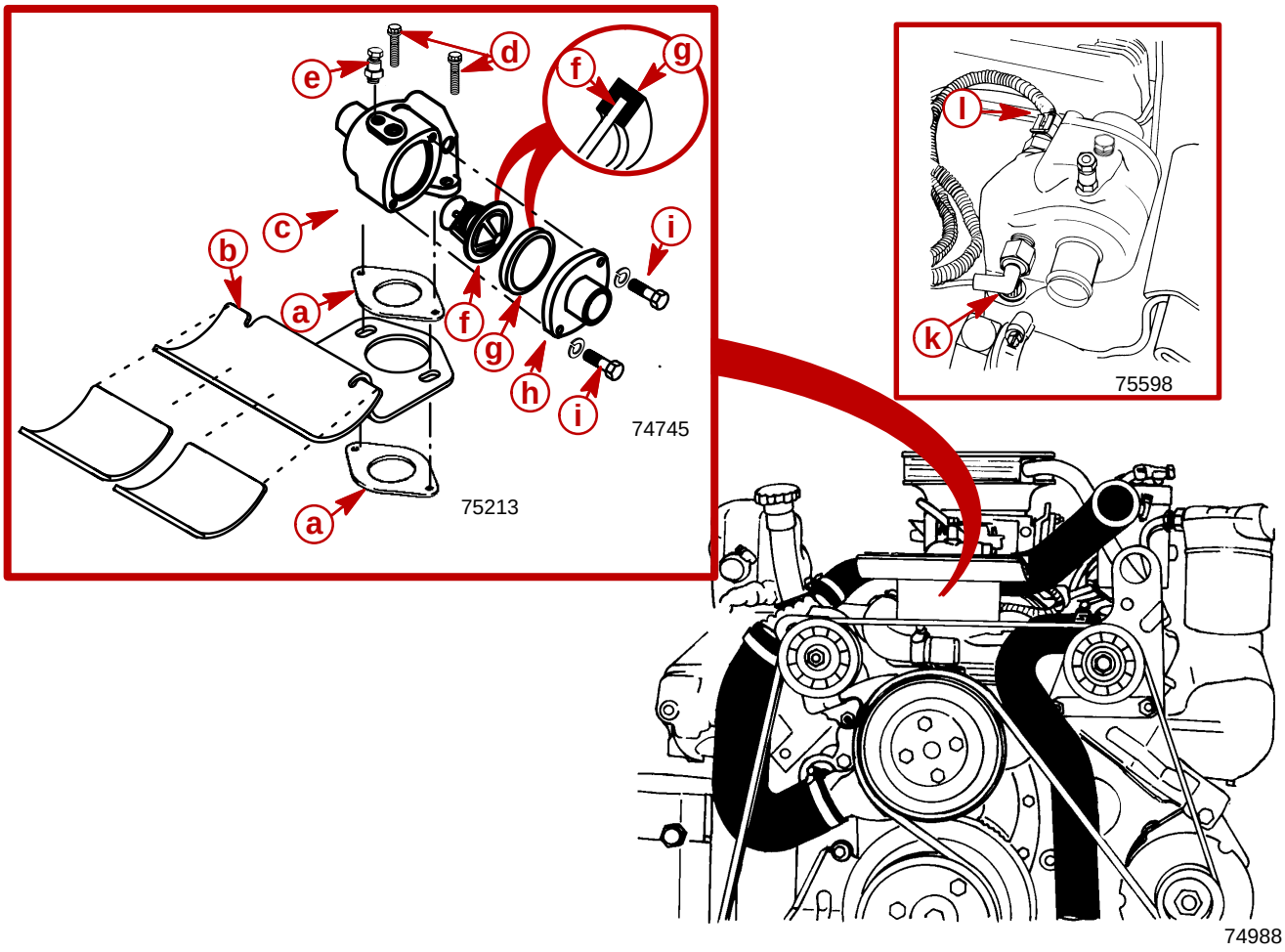
Heat Exchanger Bracket Hardware



Typical Engine Shown

- **a** - Gasket
- **b** - Heat Exchanger Bracket and Pads
- **c** - Thermostat Housing
- **d** - Screws, Stainless Steel
- **e** - Bleeder Valve
- **f** - Thermostat
- **g** - Quad-Ring Seal
- **h** - Outer Diameter of Thermostat
- **i** - Thermostat Cover
- **j** - Screws with Lockwashers
- **k** - Engine Temperature Gauge Sender
- **l** - ECT Sender

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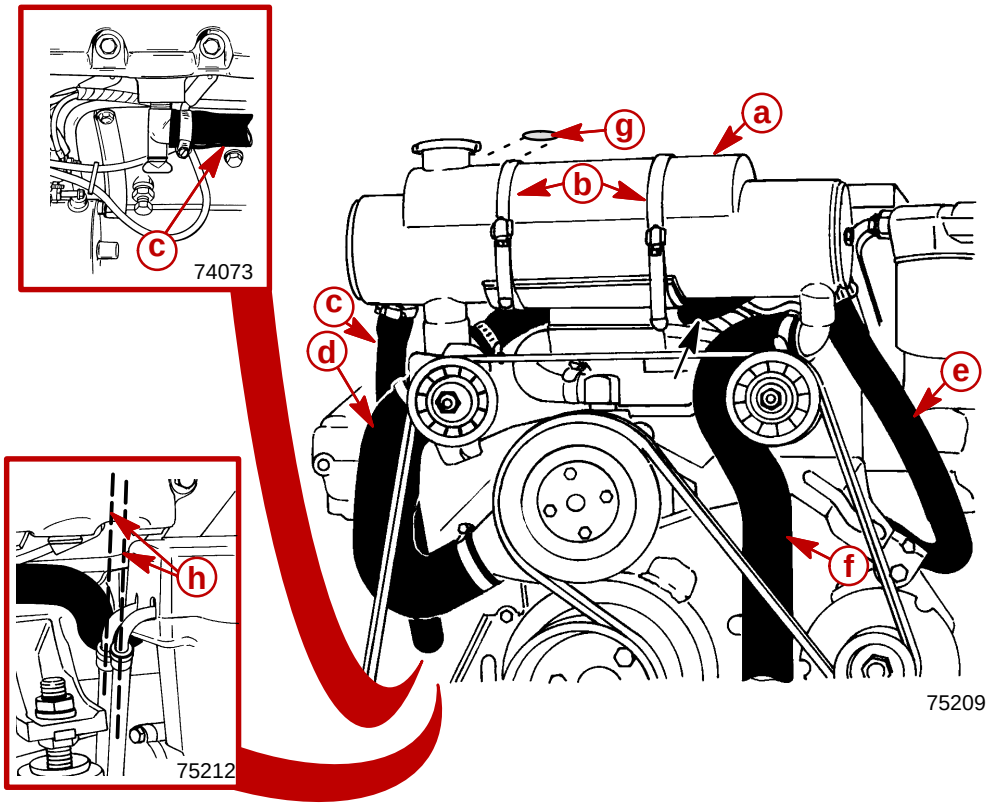
Heat Exchanger Hose Connections



Typical Engine Shown

- **a** - Heat Exchanger
- **b** - Large Hose Clamps
- **c** - Starboard Heat Exchanger-to-Exhaust Manifold Hose
- **d** - Water Circulating Pump Hose
- **e** - Port Heat Exchanger-to-Exhaust Manifold Hose (MCM)
- **f** - Cool Fuel System (or Seawater Pipe, if equipped)-to-Heat Exchanger Hose
- **g** - Coolant Identification Decal
- **h** - Fuel Lines Aligned to Avoid Starboard Water Hose

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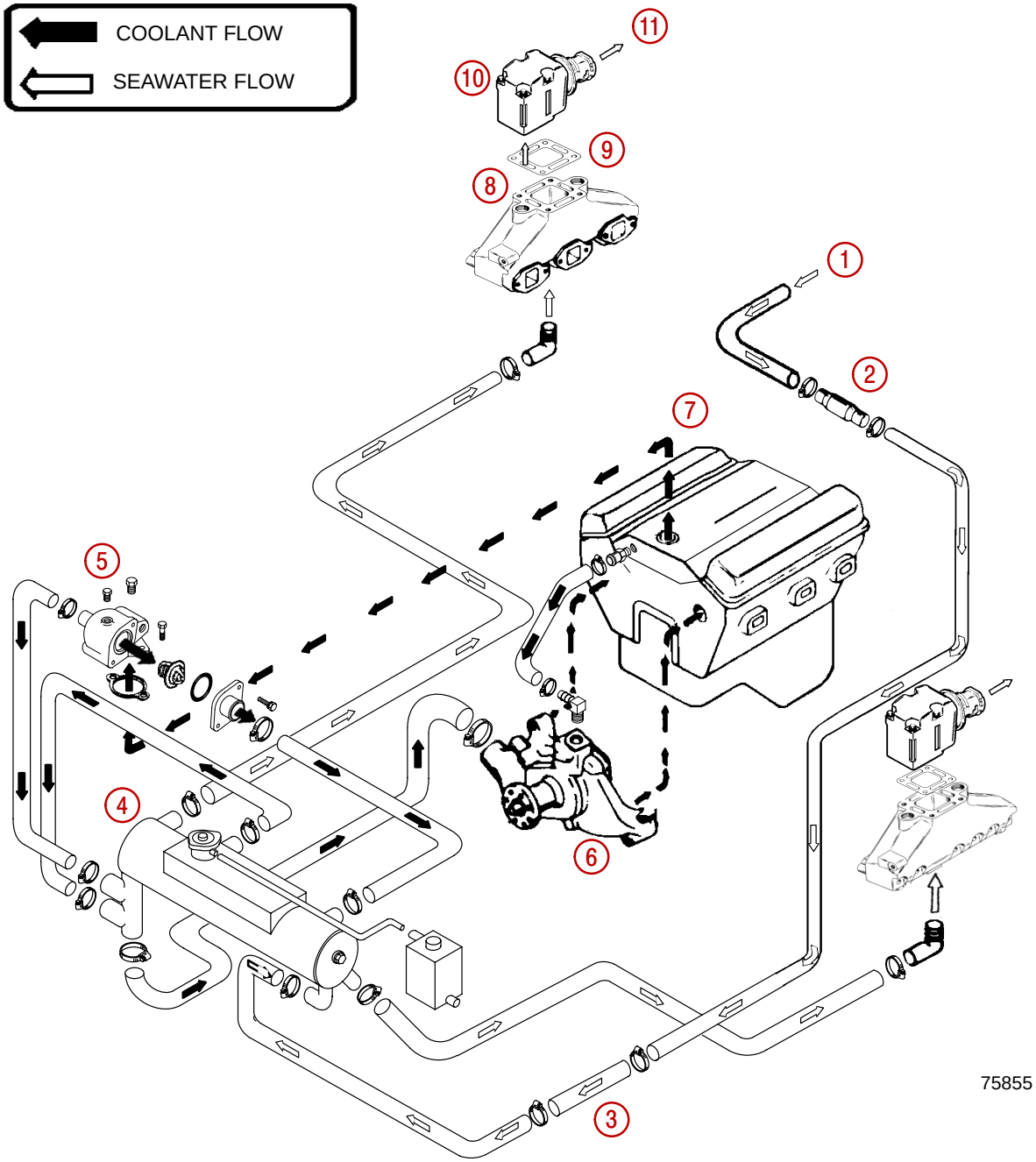
Water Flow Diagram

MCM 262 cid / 4.3L Alpha

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater Intake (From Sterndrive)
2 - Power Steering Cooler
3 - Fuel Cooler - EFI Models
4 - Heat Exchanger, Typical
5 - Thermostat Housing Assembly
6 - Engine Water Circulating Pump
7 - Engine Block And Cylinder Head Assembly
8 - Exhaust Manifold, Typical
9 - Gasket
10 - Exhaust Elbow Assembly, Typical
11 - Overboard (Water and Exhaust Discharge)

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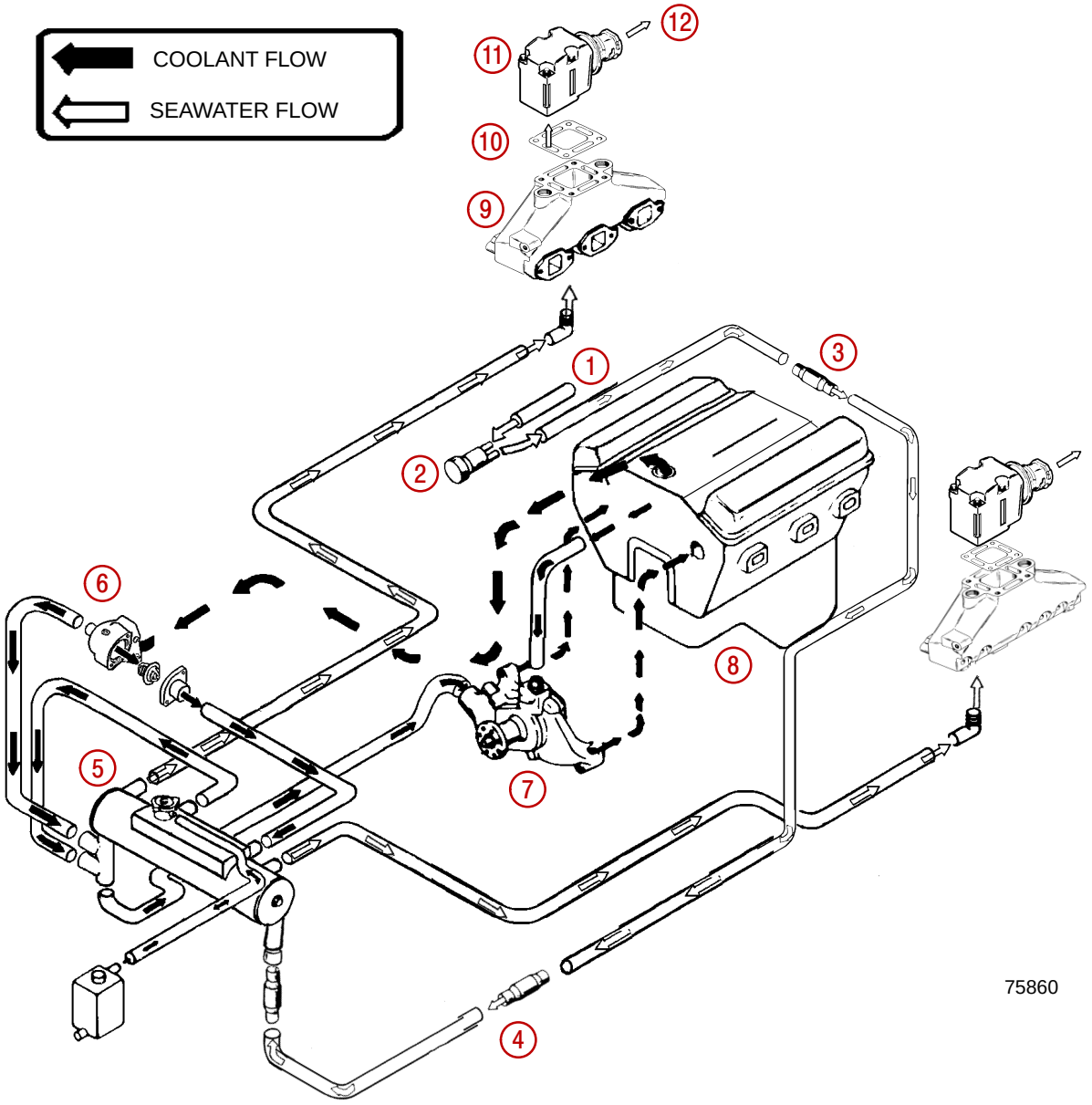
MCM 262 cid / 4.3L Bravo



1 - Seawater Intake (From Through The Hull or Through The Transom Pickup)
2 - Seawater Pump
3 - Power Steering Cooler
4 - Fuel Cooler, If Equipped
5 - Heat Exchanger, Typical
6 - Thermostat Housing and Cover Assembly
7 - Engine Water Circulating Pump
8 - Engine Block and Cylinder Head Assembly
9 - Exhaust Manifold, Typical
10 - Gasket
11 - Exhaust Elbow Assembly, Typical
12 - Overboard (Water and Exhaust Discharge)

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EXHAUST SYSTEM

Section 7A - General

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Exhaust Elbow Risers 7A-2
Through The Transom Exhaust 7A-3

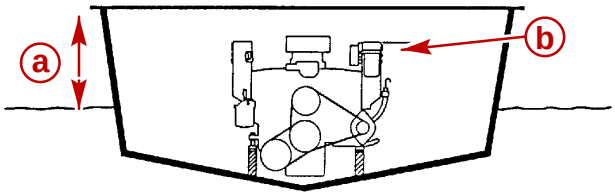
7 A

Exhaust System Requirements

IMPORTANT: It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Limited Warranty, unless this damage is the result of defective part(s).

Exhaust Elbow Risers

On all engines to determine if exhaust elbow risers are required, take measurements (**a**) and (**b**), with boat at rest in the water and maximum load aboard. Subtract (**b**) from (**a**). If (**a**) minus (**b**) is less than specified in chart, select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow.



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Exhaust Elbow Measurement

a - From Waterline To Top Of Transom
b - From Highest Point On Exhaust Elbow To Top Of Transom

Model	(a) Minus (b) Must Be at Least
All	13 in. (330 mm)

Through The Transom Exhaust

When designing and installing exhaust system, the following must be observed:

Minimum Hose Size		
Model	**Single Outlet**	**Dual Outlet**
All	4 in. (102 mm)	3 in. (76 mm)

1. Exhaust flanges must be of proper size to accommodate 4 in. (102 mm) I.D. exhaust hoses. They must also be equipped with internal water shutters, and use an exhaust flapper over each outlet.
2. The exhaust hoses and pipes must not be higher than exhaust elbows at any point.
3. The exhaust outlet must be located so that a minimum of 1/2 in. (13 mm) drop per foot (305 mm) downward pitch exists in the exhaust hose from the engine exhaust elbow to the outlet. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose.
4. Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard.
5. Back pressure must not exceed 4 in. (102 mm) of mercury when measured with a mercury manometer to exhaust elbow outlets.

There are no kits to convert these engines from through the drive to through the transom exhaust. By using block off plates, inboard exhaust elbows, exhaust hoses and transom outlet fittings, some engines have been converted to through the transom exhaust. In addition to the preceding information, the following should be adhered to:

- “Exhaust Elbow Measurement” (as previously outlined) must be checked.
- Block-off plates (for thru drive exhaust system) must be able to prevent water from entering boat (Quicksilver Block-Off Plate Part Number 97350T--1). Refer to appropriate Sterndrive Manual.
- Exhaust bellows (between gimbal housing and bell housing) should be removed to allow propeller to draw air. Refer to appropriate Sterndrive Manual.

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EXHAUST SYSTEM

Section 7B - Manifolds, Elbows and Risers

7 B

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Cleaning and Inspection	7B-4		

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Hose Clamps		Securely	
Exhaust Elbow or Risers to Manifold		33	45
Exhaust Manifold		25	34

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
Quicksilver Loctite 510 Sealant	92-804874

Exhaust Riser (Kit)

3 in. (76 mm) and 6 in. (152 mm) riser kits are available for engines with two piece manifolds.

IMPORTANT: All listed MCM Models can be adapted to 9 inch (228 mm) exhaust risers by stacking 3 inch (76 mm) riser kit and 6 inch (152 mm) riser kit.

No riser kit is available for one piece manifold. An exhaust extension kit may be needed when risers are installed.

Disassembly

⚠ WARNING

Avoid possible injury or damage to equipment should wires be accidentally shorted. Disconnect BOTH battery cables from battery before proceeding.

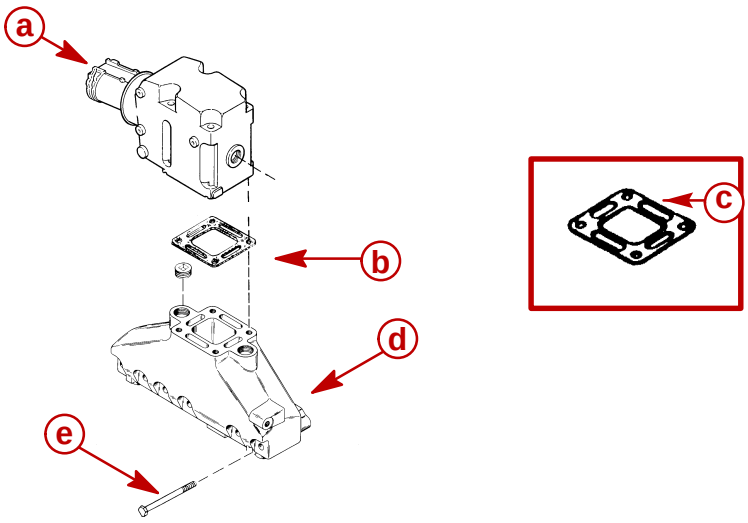
1. Disconnect battery cables from battery.

⚠ CAUTION

To avoid severe engine damage. Exhaust elbows and manifolds MUST BE drained to prevent water from entering combustion chambers when exhaust elbows are removed.

2. Drain water from manifold, elbow and riser, if equipped.
3. Disconnect exhaust and cooling hoses.
4. Remove any other components that are mounted to the manifold, elbow and riser, if equipped.

5. Remove elbow and riser, if equipped.
6. Remove exhaust manifold fasteners. Remove manifold assembly and discard gaskets.



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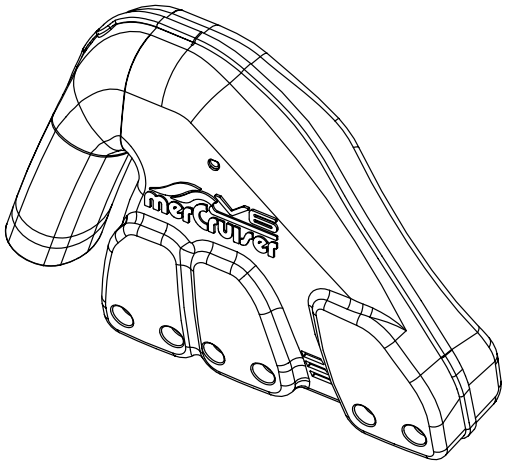
MCM 4.3L / 4.3LH / 4.3L EFI Two Piece Cast Iron Manifold

a - Exhaust Elbow
b - Restrictor Gasket
c - Open Gasket (Later Models and Service)
d - Exhaust Manifold
e - Bolts (6)



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MCM 4.3L / 4.3LH / 4.3L EFI Seawater Cooled With One Piece Cast Iron Manifold

Cleaning and Inspection

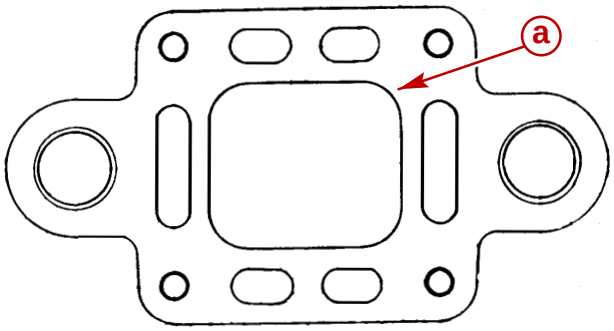
1. Clean gasket material from all surfaces and wash parts in solvent.
2. Check water passages for foreign material. Passages must be clean for efficient cooling.
3. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Quicksilver Perfect Seal before reinstalling.

4. Check for cracks.
5. To test manifold body for leaks, block-off plates, plugs or short hoses with plugged ends must be used. One block-off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block-off plate(s). Apply 40 psi (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.
6. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
7. Check the flatness of all gasket surfaces. Maximum overall is .003 in. (0.07 mm), with not more than a .001 in. (0.02 mm) difference within 1in. (25 mm).

NOTE: *Maximum material that can be removed is .010 in. (0.25 mm) to true a gasket surface up. When torquing the attaching bolts, make sure that they are not bottoming out in the manifold's threaded hole.*

8. Look at the condition of the metal around the exhaust outlet in the casting. Inspect for damaged metal caused by salt water or exhaust gas corrosion in the manifold, elbow and riser, if equipped. Replace all damaged parts.

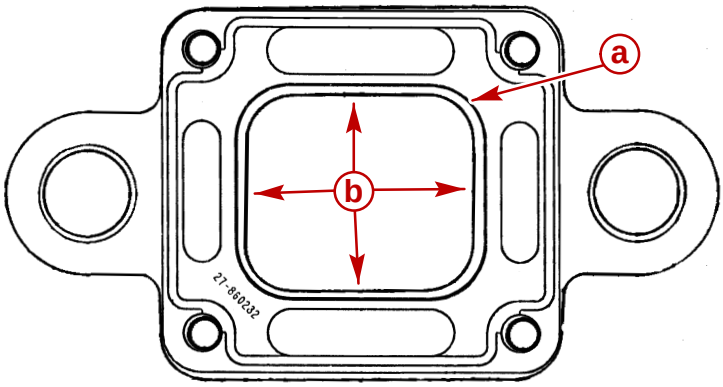


76341

a - Inspect Area Around Exhaust Outlet

9. Check the fire ring gasket fit on the manifold gasket surface. Place a new gasket on the surface. Thread 4 short 3/8-16 bolts into the bolt holes. Move the gasket fore and aft, then side to side to make sure the gasket's fire ring has manifold gasket surface under it in all 4 positions.

NOTE: *If the gasket's fire ring does not have a solid gasket surface in all 4 positions, the manifold should be replaced.*



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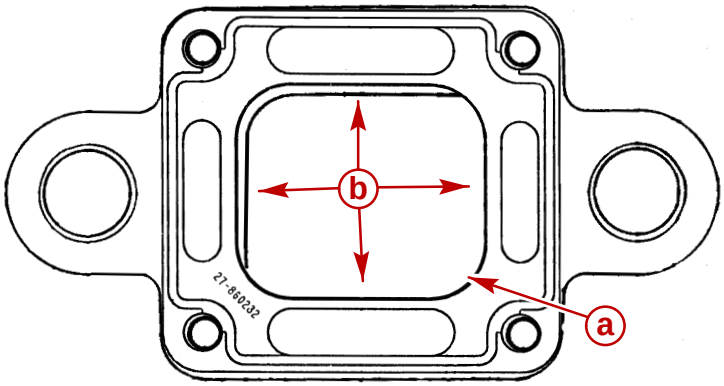
a - Gasket's Fire Ring has Manifold Gasket Surface Under It in All 4 Positions
b - Manifold Gasket Surface



76359

a - Gasket's Fire Ring Does Not have Manifold Gasket Surface Under It in All 4 Positions
b - Manifold Gasket Surface

Installation

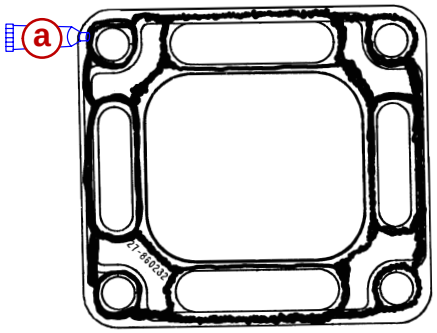
Gaskets

NOTE: *The service replacement gasket may not be the same type of gasket that was used in production.*

The fire ring gasket with 4 slots is used between all manifolds, risers and exhaust elbows.

IMPORTANT: After applying Loctite 510 to the gasket, assemble components immediately.

1. Apply a 1/8 in. (3 mm) bead of LOCTITE 510 Sealant around all holes on both sides of a new fire ring gasket.



76360

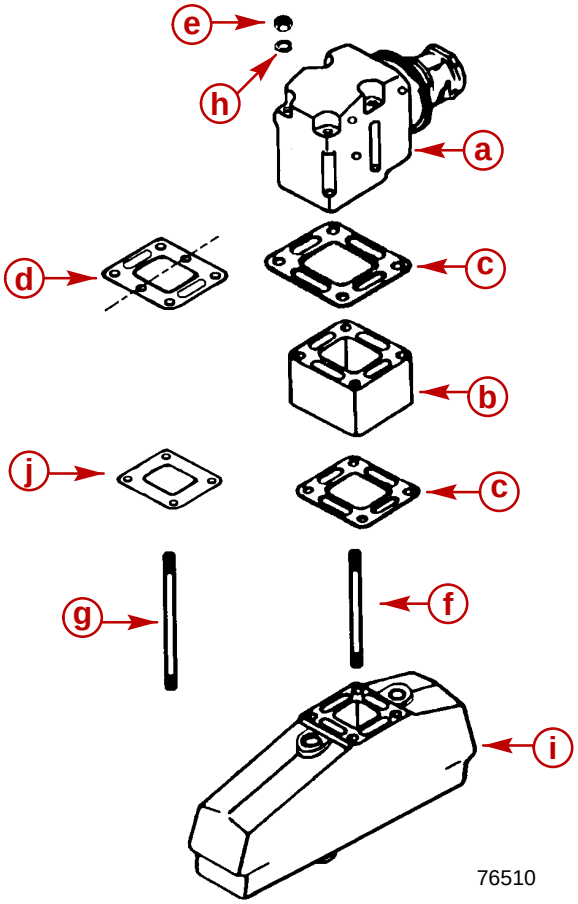
a - 1/8 in. (3 mm) Bead of LOCTITE 510 Sealant

2. Assemble parts immediately and torque fasteners to specifications.
3. Allow sealant to cure 2-3 hours before starting the engine.

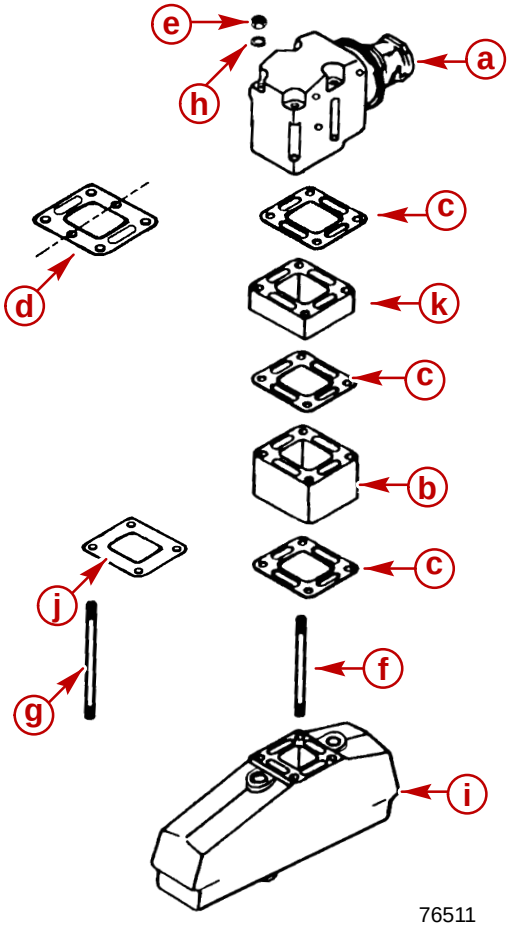
Manifold

1. Using new gasket, install exhaust manifold to cylinder head. Torque fasteners to 25 lb-ft (34Nm).
2. Using a new gasket, install exhaust elbow to exhaust manifold. Torque fasteners to 25 lb-ft (34Nm).

3 IN. RISERS



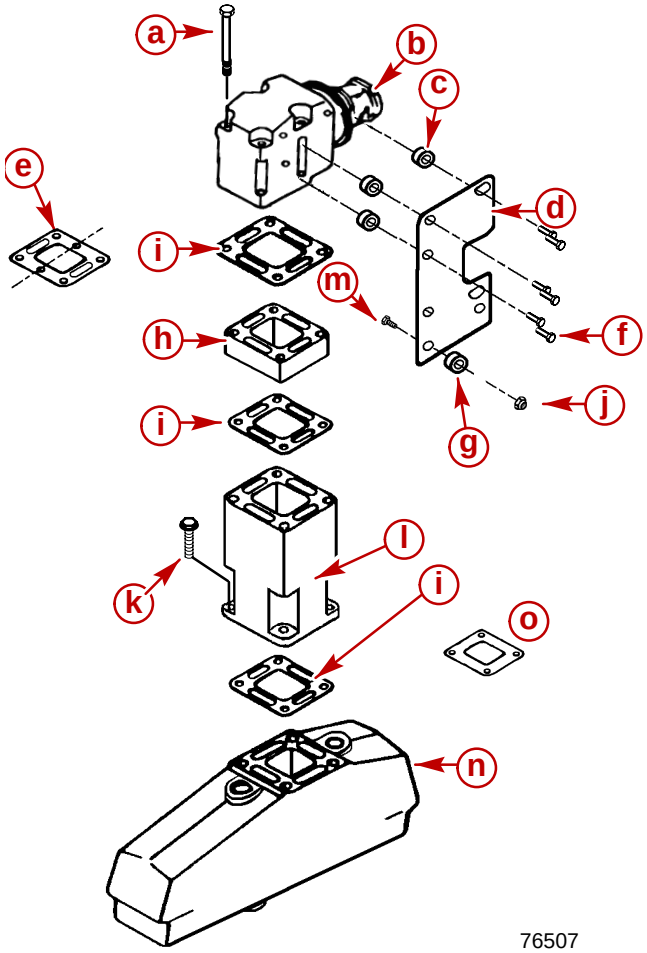
Models Without Mufflers



Models With Mufflers

- **a** - Exhaust Elbow
- **b** - 3 in. (76 mm) Exhaust Riser
- **c** - Open Gasket
- **d** - Restrictor Gasket
- **e** - Nut (8)
- **f** - Stud (8) 9-3/8 in. (238 mm)
- **g** - Stud (8) 10-3/8 in. (264 mm) Used With Remote Oil Filter
- **h** - Washer (8)
- **i** - Exhaust Manifold
- **j** - Separator Gasket - See Notice
- **k** - Muffler Spacer 1-1/4 in. (32 mm)

6 IN. RISERS



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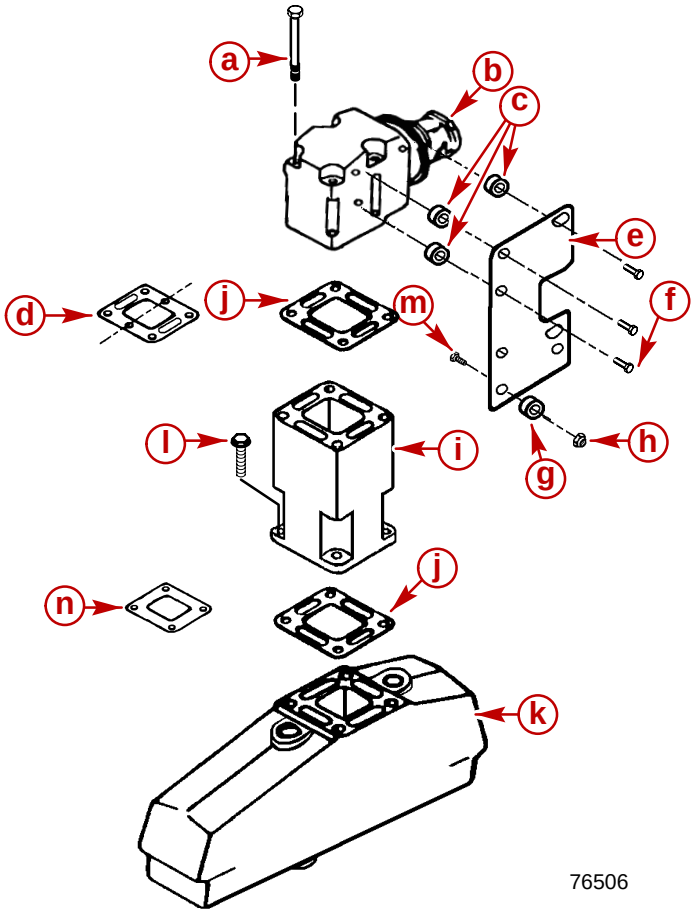

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Models With Mufflers **Models Without Mufflers**

- **a** - Screws [Supplied With Muffler Kit]
- **b** - Exhaust Elbow
- **c** - Spacer (3) [Supplied With Engine]
- **d** - Riser Bracket
- **e** - Restrictor Gasket (2)
- **f** - Fasteners (3) [Supplied With Engine]
- **g** - Spacers or Phenolic Washers in Step 5.
- **h** - 1-1/4 Inch (32 mm) Muffler Spacer
- **i** - Open Gasket (2)
- **j** - Nut (6)
- **k** - Screw (4)
- **l** - 6 Inch (152 mm) Riser
- **m** - Screw (4)
- **n** - Exhaust Manifold
- **o** - Separator Gasket (Used On Models With Exhaust Manifolds In The Closed Cooling System)

3. **Port Manifold:**

   a. Install remote oil filter and bracket.

   b. Install components on exhaust elbow (if necessary).

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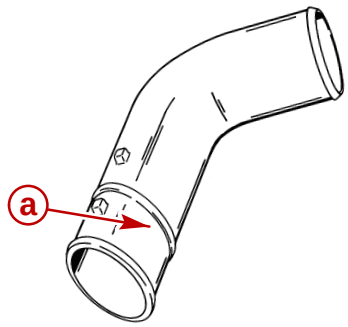
4. **Starboard Manifold:**
   a. Install bolt to secure water separating fuel filter bracket to exhaust manifold.
   b. Install shift plate assembly on exhaust elbow (MCM only).
   c. Connect instrument harness plug to engine harness, if disconnected previously.
   d. Connect both shift cables (MCM only).
5. Install exhaust elbows and cooling hoses.
6. **On Closed Cooled Models:** Refill closed cooling system to operating level with properly mixed coolant. Refer to SECTION 6B.
7. Reconnect battery cables to battery. Tighten securely.
8. Start engine and check for fuel, exhaust and water leaks.

Sterndrive Exhaust Extension

1. Install appropriate exhaust extension for MCM Models with thru prop exhaust, using two hose clamps at each end.
2. Cut along bottom edge of raised bead for 3 in. (76 mm) risers or use full length for 6 in. (152 mm) risers.



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Typical Exhaust Extension

a - Bottom Edge Of Raised Bead

3. Tighten hose clamps securely.
4. Upon first start-up of engine, check for leaks.

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EXHAUST SYSTEM

Section 7C - Collectors

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7C

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Block-Off Plate		20-25	27-34
Exhaust Pipe to Gimbal Housing			
Exhaust Pipe to T-Pipe			
T-Pipe to Gimbal Housing			
Upper Exhaust Pipe to Lower Exhaust Pipe			
Exhaust Elbow			
Air Pump Mount	Securely		
Muffler End Plate			
Mode Switch			
Hose Clamps			
Water Shutter Bolt/Nut			

Lubricants / Sealants / Adhesives

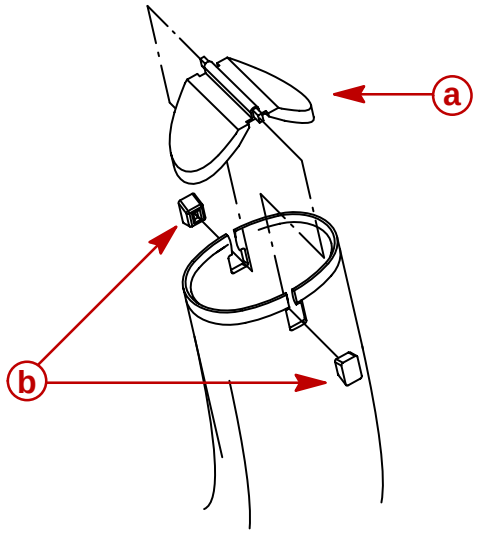
Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite 35	92-809833
Loctite Primer	92-809824
3M Brand Adhesive	92-86166--1
Quicksilver Perfect Seal	92-34227--1
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver Sound Blanket Glue	92-25234

Bullhorn Exhaust

Shutter Replacement

IMPORTANT: Engine does not have to be removed to change shutters.

1. Loosen clamps and remove exhaust pipe elbow and exhaust hose.
2. Replace water shutter as shown.
3. Reinstall pipe elbow and hose. Tighten clamps securely.



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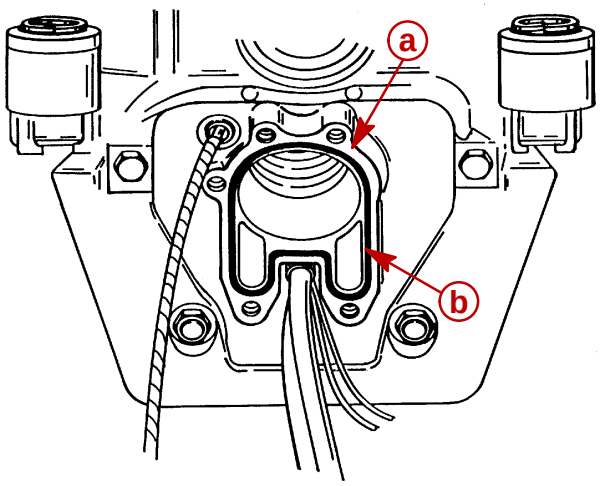
Later Style Shutter

a - Exhaust Flapper
b - Rubber Grommets

Component Replacement

To replace any components in exhaust system, the following must be adhered to:

- All mating joint surfaces must be clean.
- O-ring must remain in groove to properly seal joints to prevent leakage.
- Torque all bolts to 20-25 lb-ft (27-34 Nm).
- Tighten all clamps securely.



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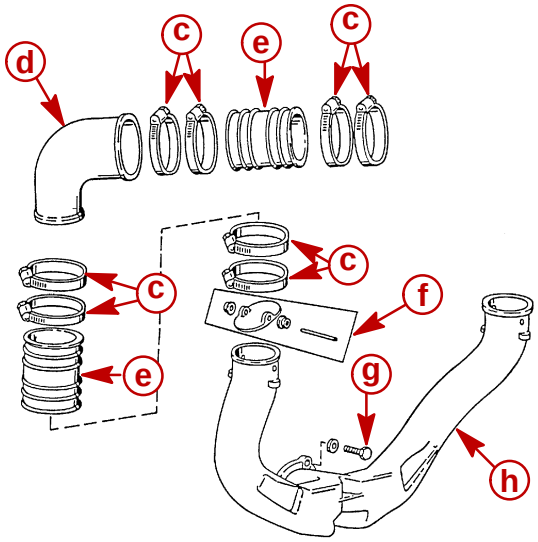
a - Mating Surface
b - O-Ring



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a - Mating Surface
b - O-Ring
c - Clamps
d - Exhaust Pipe Elbow
e - Exhaust Hose
f - Water Shutters
g - Bolts and Lockwashers
h - Exhaust Pipe

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DRIVES

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8 A

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Drive Shaft To Bearing Support Flange (MCM Models)		50	68
Drive Shaft To Output Shaft (MCM Models)			
Flywheel Housing To Block (MCM Models)		30	41
Output Shaft Housing To Flywheel Housing (MCM Models)			
Engine Coupling		35	48
Bearing Support Housing Attaching Bolts		35-54	47-73
Coupling Set Screws (If Equipped)		Securely (See Note)	

NOTE: *Safety wire set screws.*

Tools

Description	Part Number
Quicksilver Alignment Tool	91-805475A1
Quicksilver Slide Hammer Puller	91-34569A1

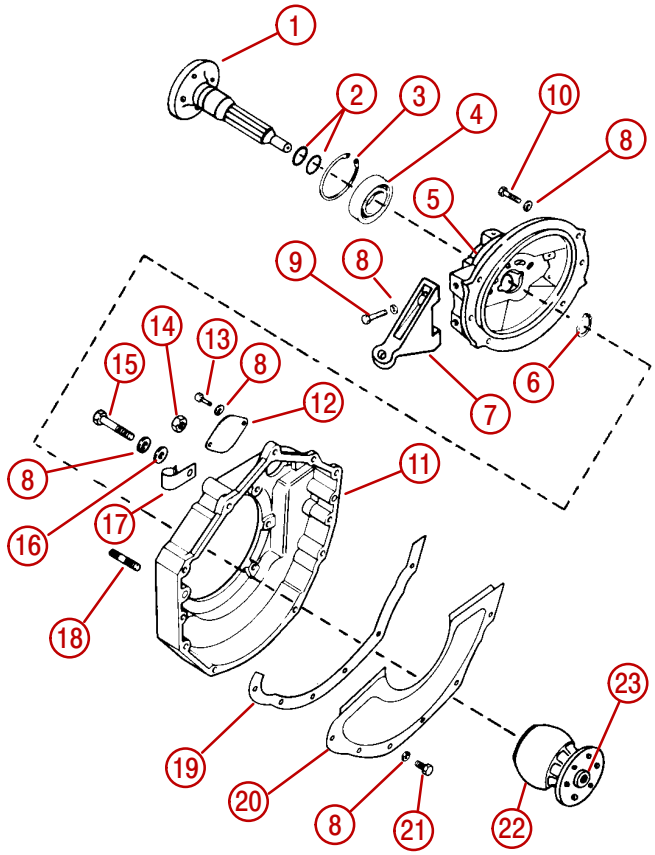
Lubricants / Sealants / Adhesives

Description	Part Number
2-4-C Marine Lubricant With Teflon	92-825407A3
U-Joint and Gimbal Bearing Grease	92-828052A2
Quicksilver Engine Coupler Spline Grease	91-816391A4
Quicksilver Loctite 27131	92-809820
Loctite 290	Obtain Locally

Flywheel Housing / Output Shaft Housing Repair

NOTICE
The following procedure requires removal of the drive shaft. In most cases, because of engine compartment space limitations, the engine also must be removed.

Exploded View



Flywheel Housing/Output Shaft Housing

1 - Output Shaft
2 - O-Rings
3 - Ball Bearing Snap Ring
4 - Ball Bearing
5 - Shaft Bearing
6 - Output Shaft Snap Ring
7 - Rear Engine Mount
8 - Lockwasher
9 - Screw (4)
10 - Screw (6)
11 - Flywheel Housing
12 - Plate
13 - Screw (2)
14 - Nut (1)
15 - Bolt (4)
16 - Washer (1)
17 - Clamp (1)
18 - Stud (1)
19 - Gasket
20 - Flywheel Cover
21 - Screw (7)
22 - Engine Coupling
23 - Bushing

Removal and Installation

1. Remove drive shaft as outlined following in this section.
2. If engine must be removed, refer to appropriate instructions in SECTION 2 - “Removal and Installation.”

Disassembly

IMPORTANT: This disassembly procedure, beginning with Step 1. assumes that engine does not require removal from boat. If engine removal is required, refer to SECTION 2 for removal and installation instructions. With engine removed from boat, proceed with disassembly, beginning with Step 3.

1. **If Engine Is Removed From Boat, Go To Step 3. If Engine Is In Boat:** Support rear of engine with overhead hoist or wooden blocks under the rear of the engine.
2. Remove stringer bolts (rear engine mounts).
3. Remove output shaft housing attaching screws, then remove housing.
4. Remove snap ring, then pull output shaft out of housing.
5. Remove snap ring from housing.
6. Using Quicksilver Slide Hammer Puller, remove bearing from housing.
7. Remove flywheel cover.
8. Remove flywheel housing.
9. Remove engine coupling.
10. Clean and inspect all parts. Replace any damaged parts.

Reassembly

1. Install engine coupling. Torque to 35 lb-ft (48 Nm).
2. Install flywheel housing. Torque to 30 lb-ft (41 Nm).
3. Using new gasket, install flywheel cover. Tighten screws securely.

IMPORTANT: Groove in outside diameter of ball bearing must align with grease fitting hole.

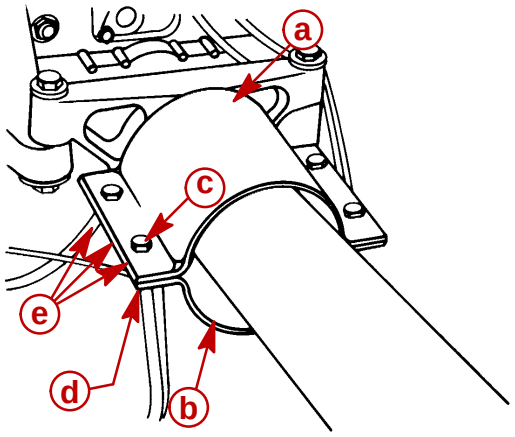
4. Install ball bearing into output shaft housing, then install snap ring.
5. Apply Quicksilver 2-4-C Marine Lubricant With Teflon to O-rings (on output shaft), then slide shaft through bearing. Secure shaft with snap ring.
6. Apply Quicksilver Engine Coupler Spline Grease to splines on output shaft.
7. Install output shaft housing to flywheel housing. Torque screws to 30 lb-ft (48 Nm).
8. Secure rear engine mounts to stringer with bolts. Tighten securely.
9. Remove hoist (or wooden blocks).
10. Install drive shaft and check alignment. (Refer to SECTION 2B for engine and drive shaft alignment if engine was removed.)
11. Using Quicksilver U-Joint and Gimbal Bearing Grease, grease ball bearing through grease fitting.

Drive Shaft Repair

Removal

IMPORTANT: It is not necessary to remove the engine to service the drive shaft.

1. Remove top and bottom drive shaft shields around transom end and engine end of drive shaft.

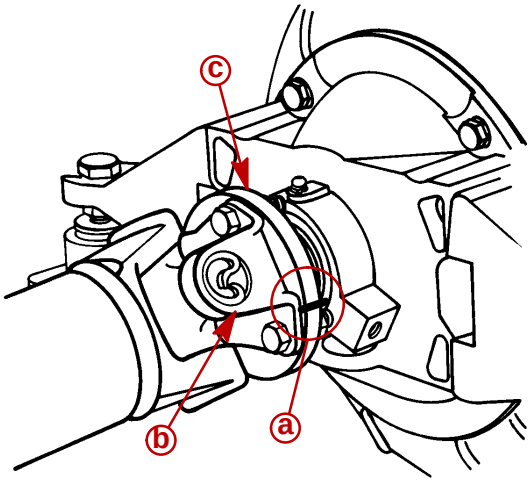


70245

Top Shield and Bottom Shield at Transom End (Engine End Similar)

a - Top Shield
b - Bottom Shield
c - Bolt 3/3-16 x 7/8 In. (22.2 mm); 4 Used
d - Nut 3/8 16: 4 Used
e - Screws (3 Used Hidden In This View)

2. Suitably mark drive shaft U-joint yokes / flange connections (engine output and drive unit input) to assist in exact same positioning during assembly at engine and transom end.

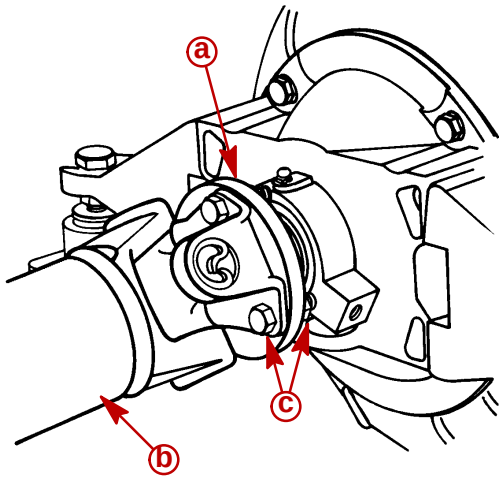


70237

Engine End Shown (Transom End Similar)

a - Suitable Mark On Flange and Drive Shaft Connection
b - Extension Drive Shaft U-Joint Yoke
c - Flange

3. Remove drive shaft fasteners and drive shaft.



70237

Engine End Shown (Transom End Similar)

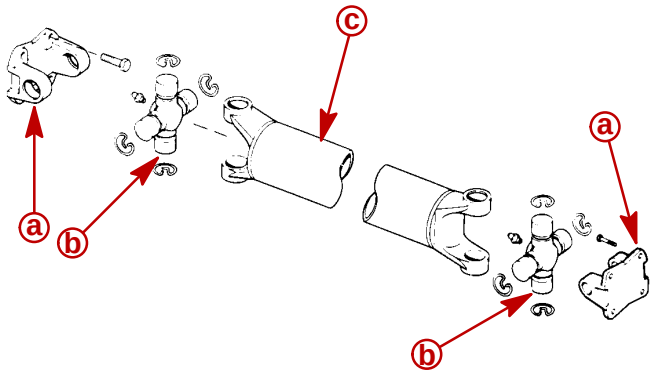
a - Output Shaft Flange
b - Drive Shaft
c - Bolt With Nut (4 Total)

Repair

⚠ CAUTION

Be sure U-joint locking rings are seated properly after replacing U-joints.

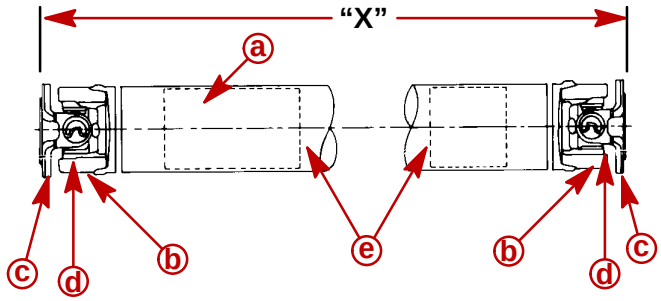
1. Replace U-joints, if required.
2. Replace flange, if required.



a - Flange
b - U-Joint
c - Drive Shaft

Replacement Drive Shafts

MerCruiser furnishes a 58 in. (1473 mm) or 34-1/2 in. (876 mm) long drive shaft with extension shaft models. Some boat manufacturers modify the drive shafts to a shorter length. Because of this, use the following procedure to obtain replacement drive shafts.



a - Tube
b - Yoke - Tube
c - Flange
d - Universal Joint
e - Sound Deadener (Cardboard Tube)

The complete drive shaft can be ordered from Mercury Marine.

Drive Shafts Modified to Shorter Lengths

The complete modified (shortened) drive shaft has to be ordered from the boat manufacturer that installed the Mercury MerCruiser Power Package.

IMPORTANT: Dana Corporation - Spicer Regional Drive Shaft Centers will not shorten replacement drive shafts for dealers or consumers.

If a boat manufacturer is currently having extension drive shafts modified, they must be modified by one of Dana Corporation - Spicer Regional Drive Shaft Centers to maintain Mercury MerCruiser warranty. The modified drive shaft must meet the following specifications.

- U-joints aligned radially within 0° (± 1/2°).
- U-joints greased, after welding, with Quicksilver U-Joint and Gimbal Bearing Grease.
- Assembly balanced to within 1.5 oz-in. (0.01 Nm) to 4500 rpm.
- Tube to have .005 in. (0.127 mm) to .010 in. (0.254 mm) interference fit with tube yoke.
- Tube must be straight and round within .015 in. (0.381 mm).

Installation

IMPORTANT: The following instructions are to be used if ONLY the drive shaft was removed for service. Refer to appropriate sections for installation of other components which require special alignment.

1. Grease both drive shaft universal joints with Quicksilver U-Joint and Gimbal Bearing Grease.

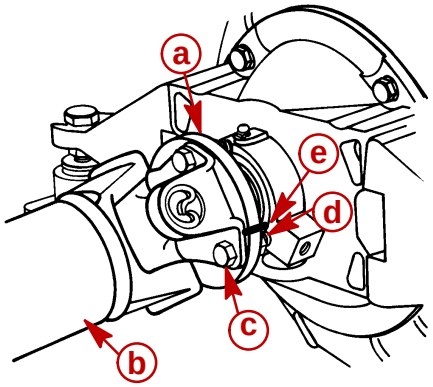
⚠ CAUTION

When attaching shaft in next step, BE SURE that the pilot on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges MUST BE flush with each other prior to tightening screws or screws may come loose during operation.

⚠ CAUTION

Failure to properly align shaft flanges with matching marks made on disassembly may cause improperly aligned drive unit and extension drive shaft U-joint centerlines resulting in a severe vibration problem.

2. As shown, attach drive shaft output flange and input shaft flange exactly as marked upon disassembly. Torque fasteners to 50 lb-ft (68 Nm).

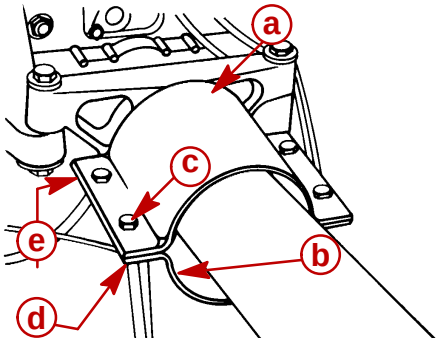


70237

Engine End Shown (Transom End Similar)

- **a** - Output Shaft Flange
- **b** - Drive Shaft
- **c** - Bolt 7/16-20 x 1-1/2 In. (38 mm) Long (4 Used)
- **d** - Nut 7/16-20 (4 Used)
- **e** - Suitable Matching Marks Made Upon Disassembly - Aligned

3. Apply Loctite 27131 to threads of bottom drive shaft shield retaining screws and install bottom shields on engine and transom end. Then install both top shields as shown. Torque all fasteners to 30 lb-ft (41 Nm).



70245

Top Shield and Bottom Shield at Transom End (Engine End Similar)

- **a** - Top Shield
- **b** - Bottom Shield
- **c** - Bolt 3/8-16 x 7/8 in. (22 mm); 4 Used
- **d** - Nut 3/8-16; 4 Used
- **e** - Screws (3 Used - Hidden In This View)

Bearing Support Repair

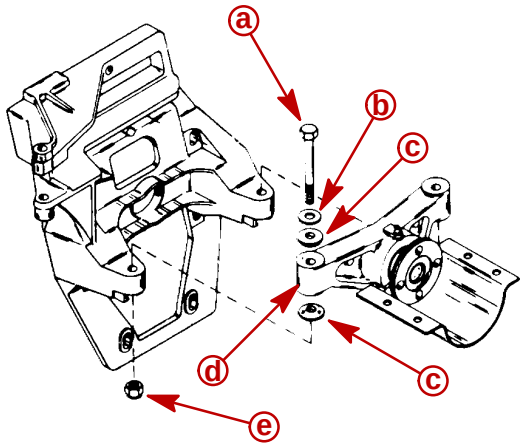
Removal

IMPORTANT: It is not necessary to remove the engine to service the drive shaft and/or bearing support.

⚠ CAUTION

If bearing support is removed, you must remove the sterndrive unit so you can properly align drive unit U-joint centerline with extension drive shaft U-joint centerline. Lack of alignment will cause a severe vibration problem.

1. Remove drive shaft as previously outlined.
2. Remove sterndrive unit. Refer to appropriate Sterndrive Service Manual.
3. Remove bearing support and retain hardware.



75279

a - Bolt, Bearing Support (2)
b - Flat Washer (2)
c - Spherical Washer (4)
d - Bearing Support (Tailstock)
e - Nut (2)

Disassembly

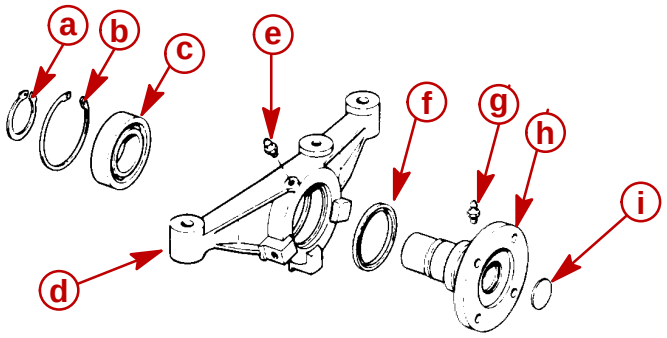
1. Remove snap ring, then remove input shaft.
2. Remove larger snap ring.
3. Using Quicksilver Slide Hammer Puller, remove ball bearing.
4. Remove oil seal.
5. If required, remove plug from end of input shaft.
6. Clean and inspect all parts.
7. Replace any damaged parts.

Reassembly

1. If removed, install new plug in end of input shaft.
2. Apply Quicksilver Loctite 27131 to outer diameter of new oil seal.
3. Press oil seal into bearing support. Lip of seal faces away from ball bearing.
4. Apply Loctite 290 to outer diameter of ball bearing and inner diameter of bearing support.
5. Install bearing (with sealed side toward snap ring) by using a press. After installation, wipe up excessive Loctite. Install snap ring.
6. Apply Loctite 290 to outer diameter of input shaft (bearing area) and inside diameter of bearing race.
7. Install input shaft, then install snap ring. Wipe up excessive Loctite.

IMPORTANT: Do not let Loctite get into ball bearing.

8. Fill bearing area with Quicksilver U-Joint and Gimbal Bearing Grease through grease fitting.
9. Apply Quicksilver Engine Coupler Spline Grease to splines of input shaft before installing drive unit.



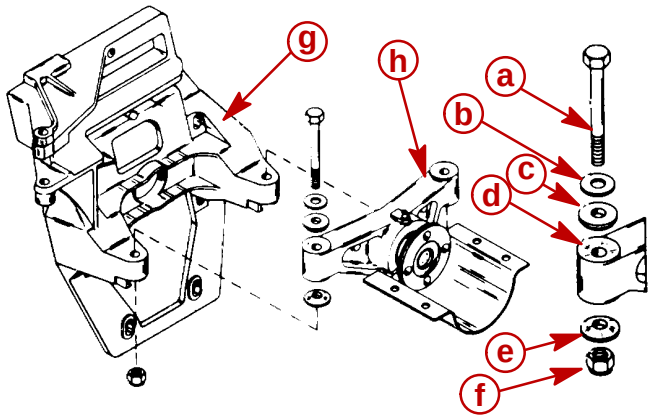
75281

a - Snap Ring - Input Shaft
b - Snap Ring - Ball Bearing
c - Ball Bearing
d - Bearing Support
e - Grease Fitting
f - Oil Seal
g - Grease Fitting
h - Input Shaft
i - Plug - Input Shaft

Installation

1. Install bearing support assembly (tailstock) on transom plate using hardware as shown. Tighten bolts until they contact. DO NOT TORQUE BOLTS AT THIS TIME.

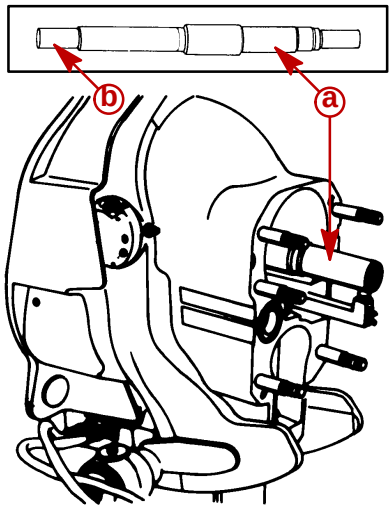
IMPORTANT: The spherical washers MUST be positioned so that the rounded side of the washers are toward the bearing support assembly as shown.



75279

- **a** - Bolts 1/2-20 x 4 In. (102 mm)
- **b** - Steel Washer (Flat)
- **c** - Spherical Washer (Rounded On One Side)
- **d** - Bearing Support
- **e** - Spherical Washer (Rounded On One Side)
- **f** - Nut 1/2-20
- **g** - Transom Plate
- **h** - Bearing Support (Tailstock)

2. Insert solid end of Quicksilver Alignment Tool through bearing in gimbal housing and into input shaft splines of bearing support.



71401

Typical Sterndrive Unit Shown

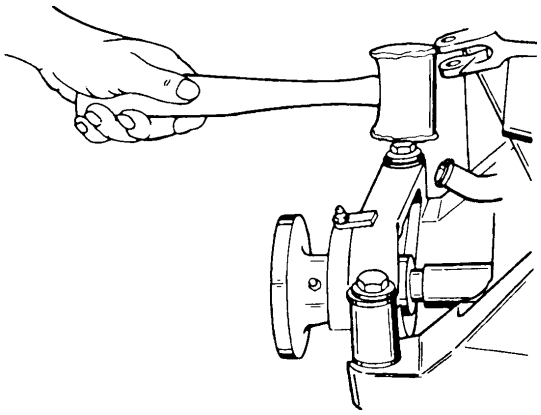
- **a** - Quicksilver Alignment Tool
- **b** - Insert This End Of Alignment Tool Through Gimbal Housing Assembly

3. DO NOT remove alignment tool from gimbal housing.

⚠ CAUTION

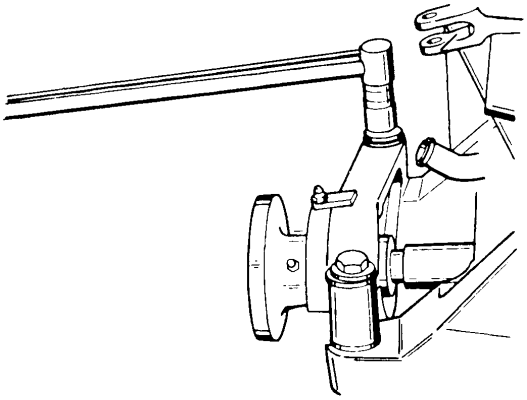
Both attaching bolts MUST be struck firmly in the following step to properly seat spherical washers. If procedure is not followed, difficulty in the installation of the sterndrive unit may be experienced and subsequent damage to the input bearing may result.

4. Strike the head of BOTH bearing support attaching bolts firmly with a hammer.



71098

5. Torque bolts to 35-54 lb-ft (47-73 Nm).



71099

6. Refer to appropriate Sterndrive Service Manual and install drive unit.
7. Refer to appropriate SECTION 2 - “Removal and Installation – Engine Installation/Alignment,” if engine was removed.

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POWER STEERING SYSTEM

Section 9A - Pump And Related Components

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9 A

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Crankshaft Pulley To Torsional Damper		35	42
Torsional Damper To Crankshaft		60	81
Pump Mounting Bracket To Engine		30	41
Power Steering Hose Fittings		23	31

Tools

Description	Part Number
Pulley Installer	91-93656A1

Special Tools

Description	Part Number
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 (313) 574-2332	
Pulley Removal Tool	J-25034

Description	Part Number
Snap-On Special Puller Tool	CJ124A

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
Transmission Fluid Dexron III or Equivalent	Obtain Locally

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Precautions

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

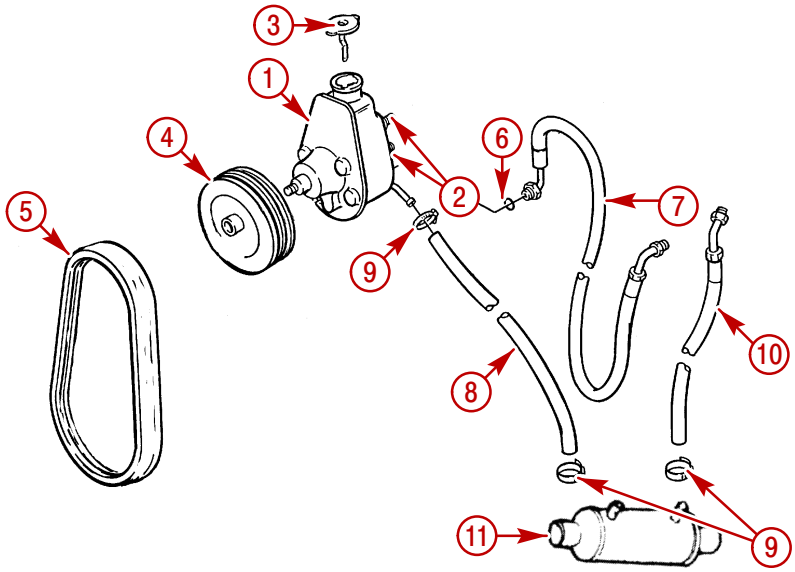
⚠ WARNING

Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠ CAUTION

Do not pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

Power Steering Pump and Components (Exploded View)

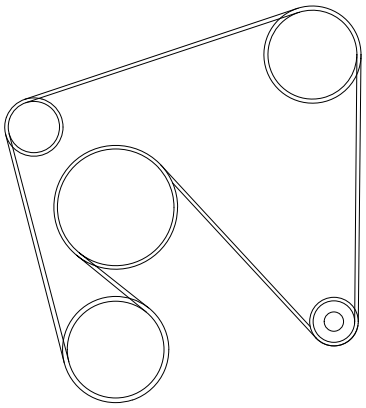


72951

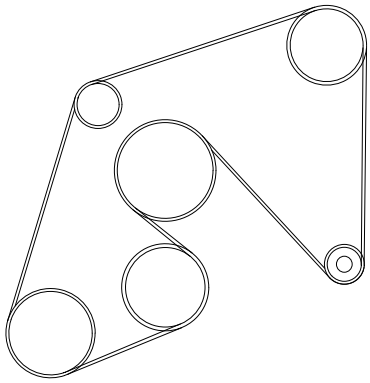
1 - Power Steering Pump Assembly
2 - Stud
3 - Cap
4 - Pulley
5 - Serpentine Belt
6 - O-Ring, High Pressure Hose Fitting
7 - Hose, High Pressure (Fittings on Both Ends)
8 - Hose, Low Pressure
9 - Clamp
10 - Hose, Control Valve To Fluid Cooler (Fitting On One End)
11 - Power Steering Cooler

Serpentine Belt Routing

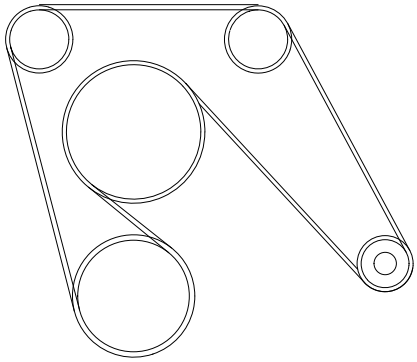
S/N 0L618999 and Below



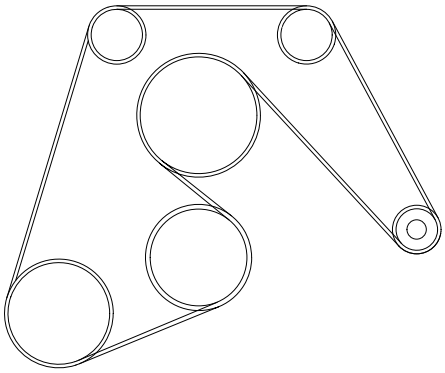
Alpha With Power Steering



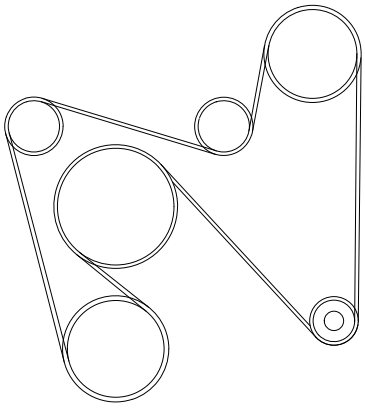
Bravo With Power Steering



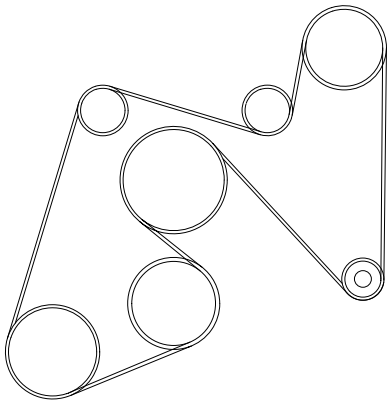
Alpha With Closed Cooling Without Power Steering



Bravo Without Power Steering



Alpha With Closed Cooling and Power Steering



Bravo With Closed Cooling and Power Steering

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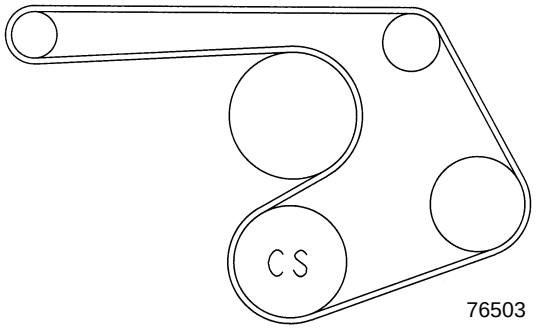
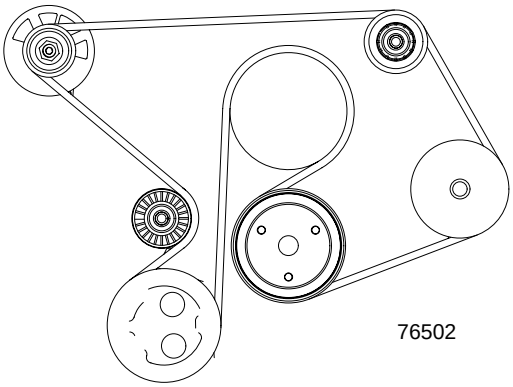
Serpentine Belt Routing (Continued)

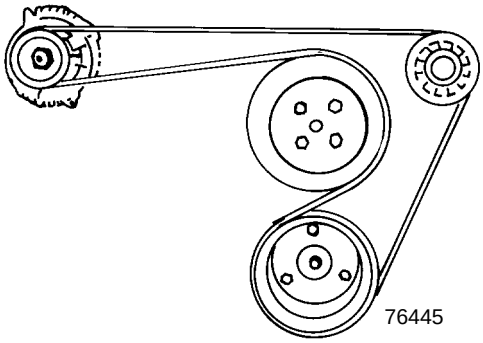
S/N 0L619000 and Above



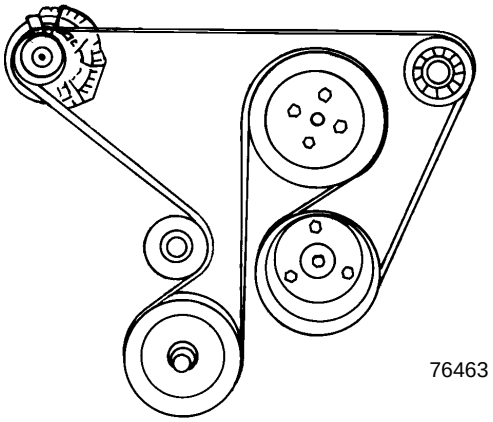
Alpha With Power Steering



Bravo With Power Steering



Alpha Without Power Steering



Bravo Without Power Steering

Serpentine Belt Adjustment

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

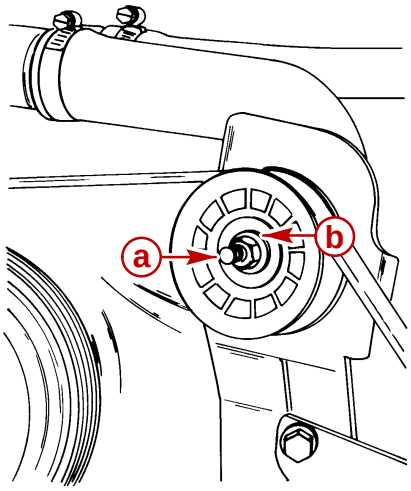
Removal

1. Remove drive belt as follows:

NOTE: *The upper, starboard idler pulley is the belt adjustment pulley.*

   a. Loosen 5/8 in. locking nut on adjustment stud.

   b. Turn adjustment stud and loosen belt. Remove belt.



75483

a - Adjustment Stud
b - Locking Nut

Installation

1. Install drive belt on pulleys.
2. Adjust tension as follows:

   a. Loosen 5/8 in. locking nut on adjustment stud. Leave wrench on adjustment stud locking nut.

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Normally this location is between the power steering pump and the belt adjustment pulley. This location will be different on engines with closed cooling or models without power steering.*

   b. Use 5/16 in. socket and tighten adjusting stud until the correct deflection of the belt is obtained at location specified above.

   c. While holding adjustment stud at the correct belt tension, tighten 5/8 in. locking nut.

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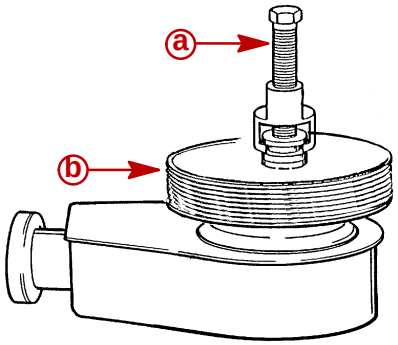
Important Service Information

Pump Pulley Replacement

REMOVAL

NOTE: *Serpentine belt pulley requires a special puller tool. See your local automotive repair dealer for appropriate tool or use Snap-On P/N CJ124A.*

1. Install appropriate puller on end of pulley and shaft as shown.
2. While holding tool with suitable wrench, turn threaded screw until pulley is removed.



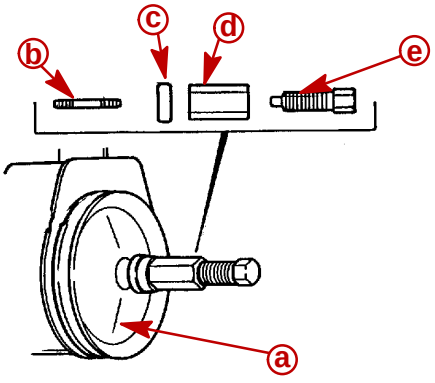
72821

a - Typical Puller
b - Serpentine Pulley

INSTALLATION

Install pulley, using appropriate pulley installation tool as follows:

1. Place pulley on pump shaft.
2. Thread stud all the way into pump shaft. Place bearing over stud.
3. Thread nut onto shaft. Thread tool shaft (and nut) all the way onto stud (threaded into pump shaft).
4. Turn large pusher nut until face of pulley is even with edge of shaft.



75751

Typical Installation Tool Shown

a - Power Steering Pump Pulley
b - Stud
c - Bearing
d - Nut
e - Tool Shaft

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Testing and Repair

Refer to appropriate MerCruiser Sterndrive Service Manual.

Checking Pump Fluid Level

Refer to SECTION 1B “Maintenance.”

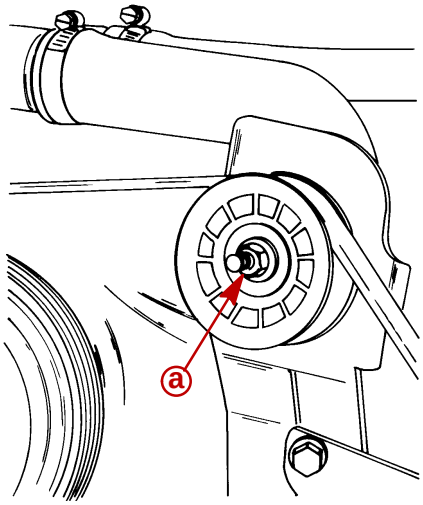
Filling and Air Bleeding System

Refer to SECTION 1B “Maintenance.”

Pump Assembly

Removal

1. Loosen the adjusting stud and remove the serpentine belt from the power steering pulley.

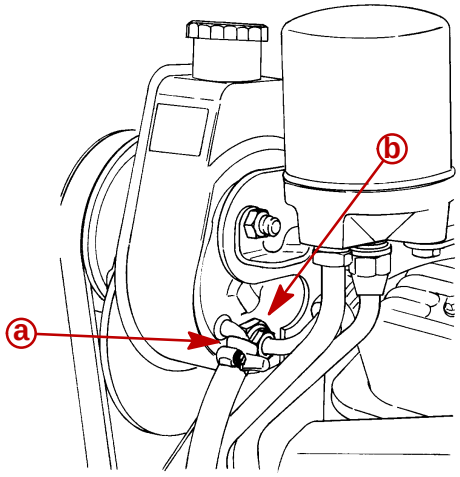


75483

a - Adjusting Nut

NOTE: *Use a suitable container catch ant power steering fluid when removing the power steering hoses.*

2. Remove the high pressure hose and return hose from the power steering pump.

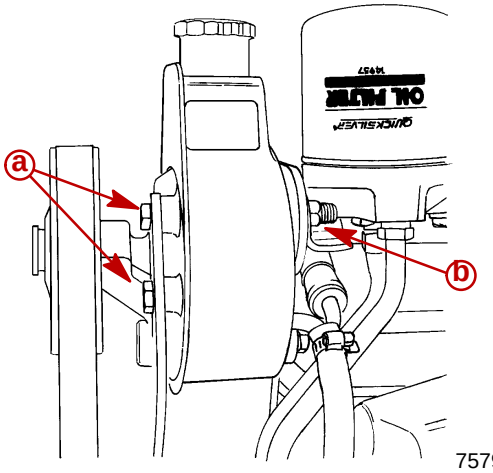


75228

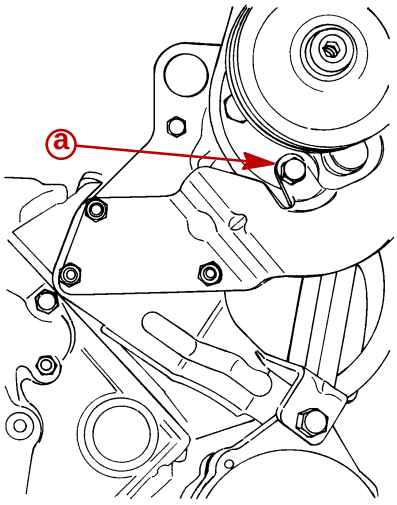
Power Steering Pump Typical Location

a - Return Hose
b - High Pressure Hose

3. Remove mounting fasteners from pump.



75798



75228

Power Steering Pump Typical Location

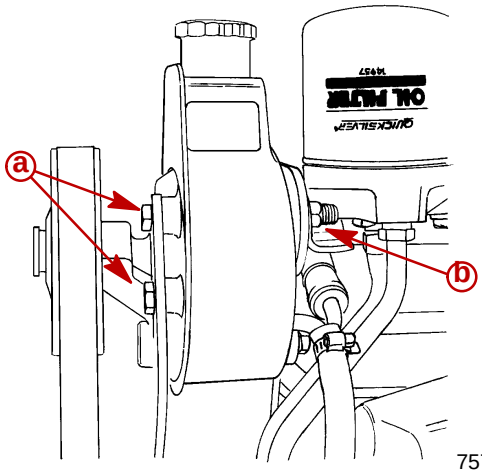
a - Nut
b - Bolts

4. Remove the power steering pump from the bracket.
5. Refer to appropriate Sterndrive Service Manual for power steering pump repair procedures.

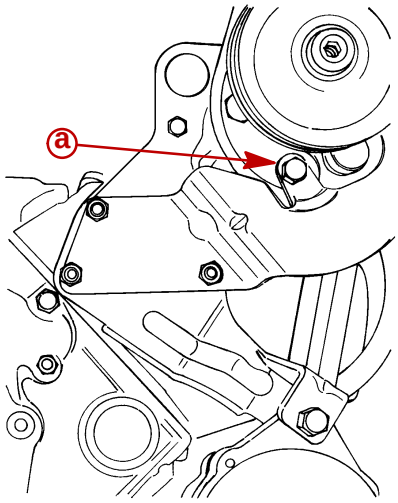
Installation

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

1. Place the power steering pump on the bracket and install the screws and nut. Torque to 30 lb-ft (41 Nm).



75798

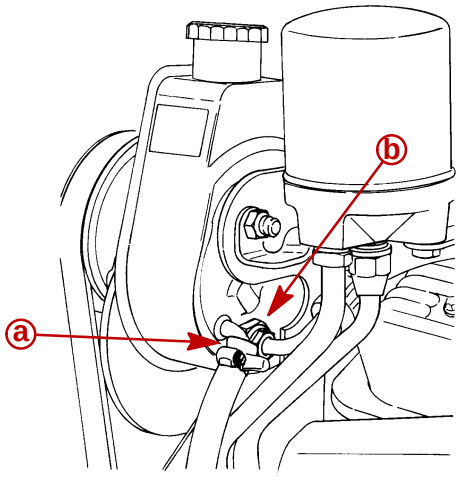


75228

Power Steering Pump Typical Location

a - Nut
b - Bolts

2. Be certain a new high pressure hose O-ring is present. Install threaded fitting in back of pump assembly. Tighten fitting securely. Connect low pressure hose on back of pump. Tighten hose clamp securely.



75228

Power Steering Pump Typical Location

a - Return Hose
b - High Pressure Hose

3. Install mounting hardware and fasteners to retain pump to bracket. (Refer to “Exploded View” for specific details on your engine.)
4. Install drive belt and adjust tension. Refer to “Pump Drive Belt Adjustment” as previously outlined.
5. Fill and air bleed system. Refer to SECTION 1B - “Maintenance.”

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Hydraulic Hoses and Fluid Cooler

The following information is provided to assist in replacement of power steering fluid hoses and to assure proper routing and connection to the cooler.

Replace high or low pressure hoses following:

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

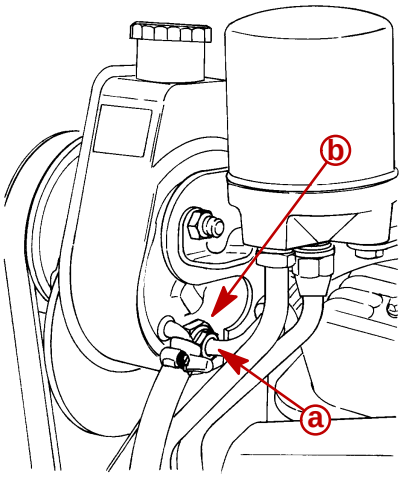
IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

High Pressure Hose (Pump-to-Control Valve)

REMOVAL

NOTE: *Catch fluid that drains from pump and hoses in a suitable container.*

1. Remove high pressure hose fitting with O-ring seal from pump fitting on rear of pump.

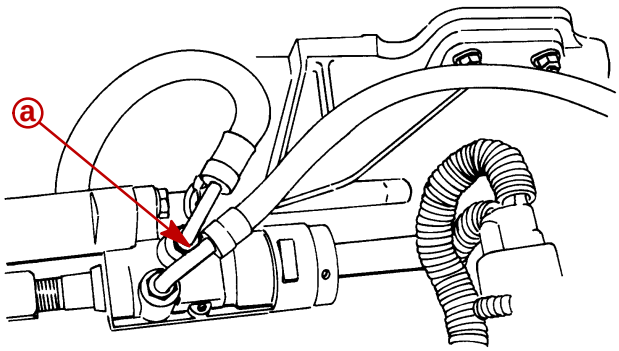


75228

Power Steering Pump Typical Location

a - High Pressure Hose Fitting (With O-Ring - Not Visible In This View)
b - Pump Fitting

2. Remove hose where routed and secured (port or starboard side), across top of engine, near valve cover.
3. Remove fitting from control valve at transom. Remove hose.



73860

a - Power Steering Hose Fitting

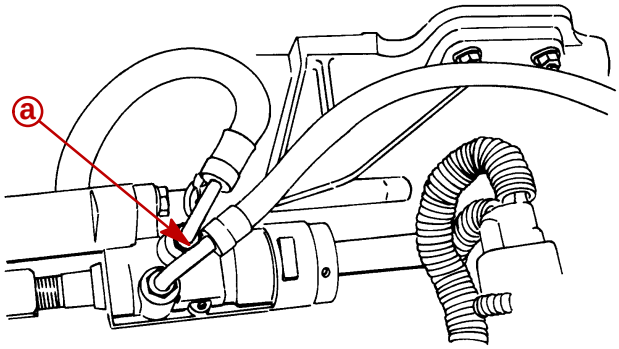
INSTALLATION

⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

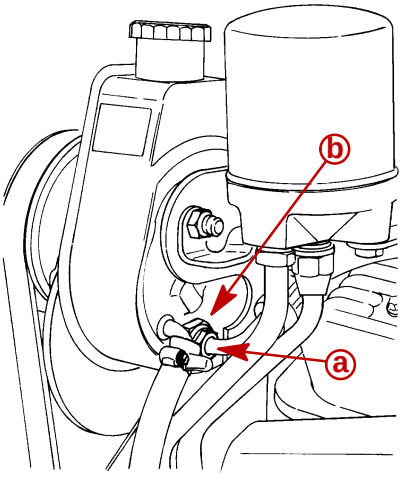
1. Position hose properly (as it was prior to removal). Install fitting and torque to 23 lb-ft (31 Nm). Do not cross-thread or overtighten.



73860

a - Power Steering Hose Fitting

2. Route hose along valve cover and secure with J-clamp(s) provided.
3. Be certain a new high pressure hose O-ring is present. Install threaded hose fitting in back of pump assembly fitting. Tighten hose fitting securely. Do not cross-thread or overtighten.



75228

Power Steering Pump Typical Location

a - High Pressure Hose Fitting (With O-Ring - Not Visible In This View)
b - Pump Fitting

4. Fill and air bleed system. Refer to SECTION 1B.

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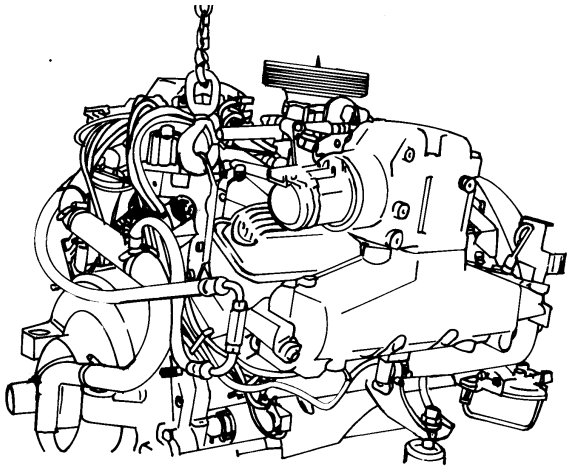
Low Pressure Hose (Cooler-to-Pump)

REMOVAL

NOTE: *Catch fluid that drains from hose, cooler and pump in a suitable container.*

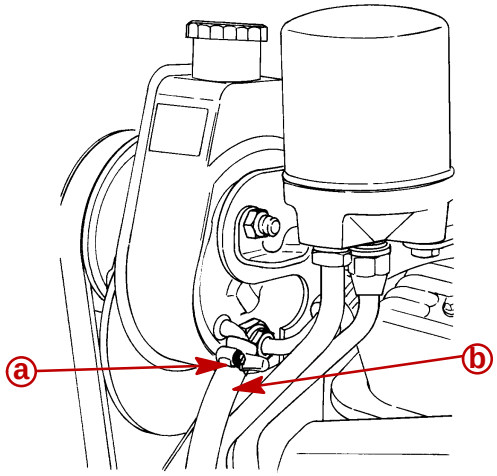
1. Loosen hose clamp and remove hose from fluid cooler.



76403

a - Hose

2. Loosen hose clamp and remove hose from back of pump.



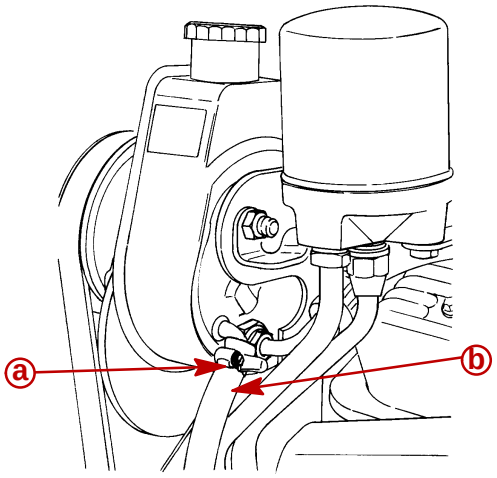
75228

Power Steering Pump Typical Location

a - Hose Clamp
b - Hose

INSTALLATION

1. Using hose clamp, install new hose on back of pump. Tighten clamp securely.

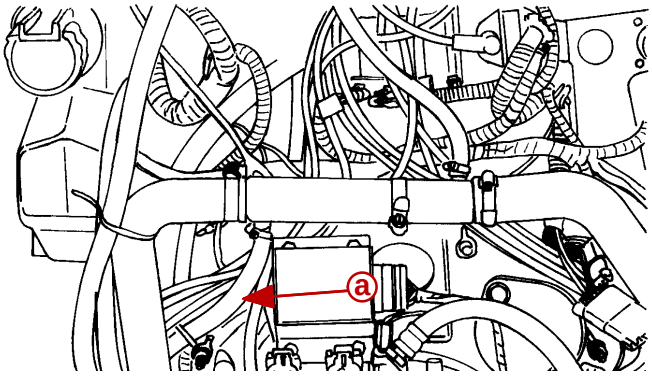


75228

Power Steering Pump Typical Location

a - Hose Clamp
b - Hose

2. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



75595

a - Hose

3. Fill and air bleed system. Refer to SECTION 1B.

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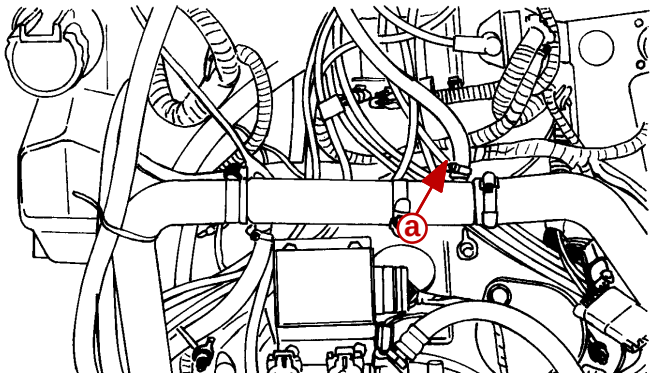
Low Pressure Hose (Control Valve-to-Cooler)

REMOVAL

NOTE: *Catch fluid that drains from hose, cooler and pump in a suitable container.*

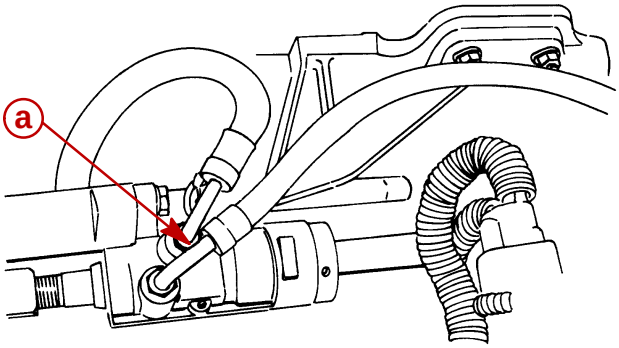
1. Loosen hose clamp and remove hose from fluid cooler.



75595

a - Hose

2. Remove fitting from control valve at transom. Remove hose.



73860

a - Power Steering Hose Fitting

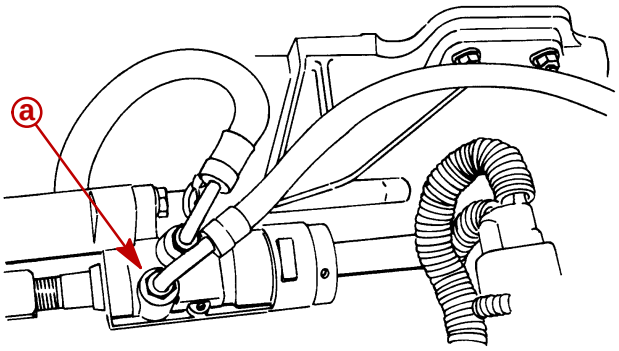
INSTALLATION

⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

1. Position hose properly (as prior to removal). Install fitting and torque to 23 lb-ft (31 Nm). Do not cross-thread or overtighten.

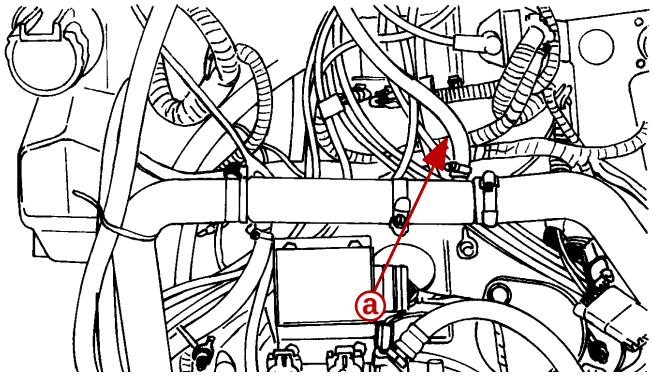


73860

a - Power Steering Hose Fitting

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

2. Route hose along flywheel housing and secure with J-clamp(s) provided.
3. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



75595

a - Hose

4. Fill and air bleed system. Refer to SECTION 1B.

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